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THE ARTICLE

UTERUS AND ITS APPENDAGES

FROM THE

Cyclopædia of Anatomy and Physiology.

COMPRISING THE

NORMAL AND ABNORMAL ANATOMY, PHYSIOLOGY

AND

DEVELOPMENT

OF THE

UTERUS, OVARY, PAROVARIUM, FALLOPIAN TUBE, VAGINA, VULVA AND PLACENTA.

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UTERUS AND ITS APPENDAGES.—The reproductive organs in woman consist of the Ovaries, Fallopian Tubes or Oviducts, Uterus, Vagina, and Vulva. These are commonly subdivided into the *formative* and *copulative* organs. To the first division belong the ovaries, Fallopian tubes, and uterus; to the second the vulva; while the vagina, on account of its offices in copulation and in labour, may be regarded as common to both.

This division nearly corresponds with another and more artificial arrangement, by which these parts are subdivided into the internal and external generative organs; those being regarded as internal which are protected within the body and concealed from view, while those which can be easily seen are termed external: the line of demarcation being here at the entrance to the vagina.

Of the several organs just enumerated, the uterus has doubtless, on many accounts, prior claim to attention. It is the largest of these parts. It is that which contributes the greatest amount of material to the new organism which it contains and protects. It is that part in which alone a direct connection of attachment subsists between the fruit and the parent. Its functions, so far as they contribute to each individual act of reproduction, are exercised for much longer periods of time than those of any other portion of the generative apparatus. It exerts a powerful reflex

influence, especially during pregnancy, upon other parts and organs. The diseases and accidents to which it is liable are more numerous, and are attended by greater danger to life than those which affect any other portions of these structures, whilst its several morbid states, as well as its natural condition, may be ascertained during life with a degree of precision which virtually removes the uterus from the category of internal parts.

But it is only in a practical or obstetric point of view that the uterus can be regarded as the most important of the generative organs. Physiologically considered, it is by no means entitled to the foremost place; for although the presence of the uterus is necessary to the completion of the generative act in its regular course, yet reproduction to a certain extent may be accomplished without it. The uterus is necessary to reproduction, first, as affording the only channel by which the seminal fluid can obtain access to the ovum; and next, as constituting, together with the vagina, the only natural passage for the exit of the fully matured ovum, which requires this contractile organ to effect its expulsion by that passage: such expulsion not being essential to the generative act because the fœtus may be extracted by the Cæsarean section without necessary loss of life either of the parent or offspring, while other parts—the Fallopian tubes for example—may, to a certain extent, perform the offices of a uterus in all that relates to the protection and nutrition of the ovum. Moreover, the entire removal of the uterus may have no other effect upon the individual than that of preventing impregnation and menstruation by the simple abstraction of the parts necessary thereto.

On the other hand, the ovary, though constituting only a small portion of the reproductive organs, is nevertheless that part to which all the rest are subservient. It is the organ which furnishes the generative element essential to the reproductive act. It is that part which, in a great measure, regulates the growth of the body, and determines the distinctive characters of the sex. It is the organ upon the presence of which depends the sexual passion and the process of menstruation; whose congenital deficiency is indicated by the absence externally of all signs of a secondary sexual character; whose artificial removal entirely unsexes the individual, and the decline of whose functional activity, as age advances, is the cause of the generative faculty being lost in the female long before the ordinary term of life has expired, and at

Fig. 368.

Fig. 368.

Uterus and appendages of an adult virgin, posterior aspect. (*Ad Nat.*)

a, uterus; *bb*, ovary; *cc*, Fallopian tube or oviduct; *dd*, fimbriated extremity or infundibulum of the tube; *ee*, terminal bulb of the duct of Müller; *f f*, portion of broad ligament and blood-vessels; *g*, vaginal portion of cervix uteri; *h*, os uteri externum; *i*, anterior and *l*, posterior wall of vagina; *m*, ligamentum ovarii; *n*, tubo-ovarian ligament.

a much earlier period than that at which the power of procreation ceases in the other sex.

In a physiological sense, therefore, the uterus, as well as every other part of the generative apparatus, must be regarded as an appendage of the ovary; and the title "Uterus and its Appendages" is employed, in accordance with ordinary usage only, as the heading of this Article, in which it is proposed to consider the structure and functions of the entire female generative organs as they exist in Man.*

OVARY.

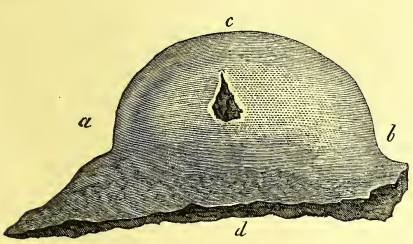
Normal Anatomy.

(Syn. *Ovarium*, *Testis Muliebris*, Lat.; *Ovaja*, Ital.; *Ovaire*, Fr.; *Eierstock*, Germ.; *Eijerstok*, Dutch.)

The ovaries (*fig.* 368. *b*, *b*) constitute two follicular glands appropriated to the formation of the female generative element. They are perfectly closed, resembling in this respect the ductless glands. Each, however, is furnished with its proper excretory duct, (*fig.* 368. *c*, *c*) between which and the gland a temporary connection is established, at certain intervals, during that period of life over which the reproductive faculty extends.

Form. — The ovary is not usually fully developed until some time after the establishment of puberty. It is then of an oval form

Fig. 369.



Ovary of a young adult virgin before the surface has become scarred by repeated discharges of ova. (*Ad Nat.*)

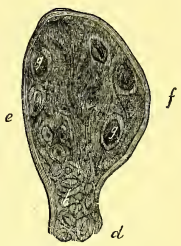
a, distal, and *b*, proximal extremity; *c*, superior, and *d*, inferior border. In the centre is laid open a Graafian follicle from which an ovum had recently escaped by spontaneous rupture.

(*fig.* 368. *b*, and *fig.* 369.), flattened on its sides, and somewhat resembling the testis in figure, but rarely or never, in a state of health, attaining to the full size of that organ.

The following division may be made of its superficies: viz., into two sides, situated anteriorly and posteriorly with regard to the body; two extremities, outer and inner; and two borders, superior and inferior.

Of the two sides, that which is directed anteriorly (*fig.* 370. *e*) is both shorter and less

Fig. 370.



Vertical section of ovary. (*Ad Nat.*)

The posterior surface, *f*, more rounded than the anterior, *e*; at *h* are numerous blood-vessels divided; *gg*, Graafian vesicles; *d*, place of entrance of vessels between the layers of the broad ligament.

convex than the posterior, which is generally rounded and gibbous (*fig.* 370. *f*). In this respect the ovary resembles the uterus, whose posterior surface is always more rounded than the anterior; by attention to this peculiarity the right ovary may be readily distinguished from the left after these organs have been detached from the uterus.

Of the two extremities, the outer or distal (*fig.* 369. and *fig.* 372. *a*) is usually rounded and bulbous, whilst the inner (*figs.* 369. and 372. *b*) becomes gradually attenuated until its outline is merged in the proper ligament (*fig.* 368. *m*) by which the ovary is attached to the uterus. The upper and lower borders also differ from each other. The former (*fig.* 369. *c*) is convex, and forms a segment of a circle, whose diameter is continually diminishing as age advances. The latter is straight or slightly concave, constituting the base of the ovary, or the line by which it is connected to the posterior duplicature of the broad ligament (*figs.* 369. and 370. *d*).

Dimensions and Weight. — The ovary of a healthy adult measures from 1″ to 2″ in length, from 6‴ to 12‴ in depth or perpendicular diameter, and from 3‴ to 6‴ in width or transverse diameter.

These dimensions, which vary considerably in different individuals, exhibit a much wider range when the observations are extended to different epochs of life. The organ is then found to undergo far more remarkable changes in bulk and figure than are observable in the corresponding male organ.

The following table, giving the highest, lowest, and mean dimensions of twelve healthy ovaries, taken indiscriminately from women in various conditions during the period of fertility, will serve to exemplify the first of these variations: —

* For the comparative anatomy, as well as for the general treatment of the subject of generation, the reader is referred to the articles, Generation, organs of; Generation; and to those descriptive of the different classes and orders of the animal kingdom throughout this Cyclopædia. The occasional introduction here of illustrations from comparative anatomy and physiology is employed for the purpose of elucidating those questions which cannot be clearly explained by observations made only upon the human subject.

	Longitudinal.	Perpendicular.	Transverse.
Highest	2″	1″ 1‴	6‴
Lowest	1″	6‴	3‴
Mean	1″ 4‴	9‴	4½‴

Another and more accurate method of estimating the bulk of the ovary consists in weighing. The following are the extreme and mean weights of five ovaries taken from healthy adults: viz., greatest weight, 135 grs.; least, 60 grs.; mean (of five examples), 87 grs. On comparison of these results with Krause's estimate of the weight of the testis, which gives the mean weight of the male organ, also in five instances, as 354·4 grs.*, it appears that the ovary, though furnishing the larger portion of the generative element in the act of reproduction, has an average bulk of less than one quarter of that of the corresponding male gland.

Position and Connections.— The ovary is so intimately connected with the uterus, in whose changes of position, both normal and abnormal, it necessarily takes part, that it cannot be said to have any fixed or definite seat. It is most commonly found lying somewhat deeply in the lateral and posterior part of the cavity of the true pelvis, concealed from view by the small intestines, and in part covered by the Fallopian tube of the same side. Relatively to the uterus, the ovary is placed on either side of that organ, at a distance varying from 4‴ to 18‴, and behind and a little below the level of the point of entrance of the Fallopian tubes (*fig.* 368.).

Each ovary is invested by a layer of peritoneum derived from the posterior lamina of the broad ligament, to which the ovary is thus attached by a kind of mesentery.

Besides this indirect connection with the uterus, through the intervention of the broad ligament, the ovary has also another and more direct attachment by the aid of its own proper ligament (*ligamentum ovarii*), which serves to bind it more securely to the uterus. (*Fig.* 368. *m.*)

The ovary is further connected at its outer extremity to the mouth of the Fallopian tube by one of the processes of the pavilion, which serves to keep the organ always in close proximity to its excretory duct (*fig.* 368. *n*).

The distance which intervenes between the ovary and the uterus varies considerably on each side, not only in different individuals, but also in the same subject, where it is very rarely found to be equal; the right ovary, so far as my observations have gone, being farther removed than the left in the proportion of nine out of twelve instances.

During pregnancy, the ovary suffers frequent changes of position. As the uterus expands, it carries the ovary along with it into the abdominal cavity, at the same time the relative situation of these parts is materially altered, the fundus uteri gradually expanding and rising above the former level of the ovaries, whilst the latter appear to be bound down more closely to the side of the uterus, until at term their position is usually found to be below the centre of that organ.

* See art. Testis, Vol. IV. p. 976.

Component Parts.— The ovary is composed of, 1st, protecting parts, or tunics; 2nd, a parenchyma, or stroma, in which are imbedded; 3rd, the proper secreting structures, in the form of closed sacs or vesicles, containing the ova; 4th, vessels and nerves.

1. *The Protecting Parts or Tunics.*—These are two in number, and correspond precisely, both in structure and derivation, with the analogous coverings of the testis.

The peritoneal covering (*fig.* 371. a) constitutes the outermost of these coats, and consists of the layer of peritoneum derived from the posterior lamina of the broad ligament, which serves to connect the ovary with the parts adjacent. Except at its base, the ovary is so closely invested by this peritoneal lamina, that no effort with the scalpel will suffice to detach it from the tunic beneath. This intimate union, however, of the two coats ceases at the base of the ovary, where a white, irregular, and somewhat elevated line is observed on either side, extending in a horizontal direction, and rising higher on the anterior than on the posterior surface of the gland. In its intimate texture, this covering of the ovary differs in no respect from the peritoneum covering the viscera generally.

The tunica albuginea, or *tunica propria*, (*fig.* 371. bb) constitutes the special or proper covering of the ovary. It serves to give form and solidity to the organ, and to protect the ovisacs and ova from injury. This coat has a nearly uniform thickness of ⅓‴, and forms a complete investment for the ovary, except at its lower border, where the fibres are either very thinly scattered and interlaced, or are altogether wanting, leaving a longitudinal space, termed the hilum or vascular fissure, by which the vessels and nerves enter the organ. This space measures 3‴—4‴ in width, and extends along the entire base of the ovary.

The tunica albuginea has been commonly regarded as a more condensed portion of the stroma, or parenchyma, of the ovary; but from this it is readily distinguished, not only by its clear white colour, and dense and almost cartilaginous hardness, but also by its microscopic characters. On account of its extreme toughness, this tunic is not very easily separable into fragments sufficiently minute for microscopic examination. But when small portions have been so obtained, the margins of the fragments exhibit numerous close-lying and irregularly arranged fibres of developed connective tissue, projecting from a dense, structureless matrix interspersed with granules, which serves to connect the fibres together, and to which apparently is due, in a great measure, the peculiar toughness of this membrane, while its remarkable whiteness is

explained by the much smaller number of blood-vessels that it contains, as compared with the general parenchyma of the ovary. The tunica albuginea, therefore, is not merely a more condensed form of the ovarian stroma, but appears to result from a development of tissues which exist in the stroma in an elementary or embryonic form, as well as from a more close conjunction and blending of those tissues.

2. *The Parenchyma or Stroma,* (*fig.* 371. c, and *fig.* 372. *s*) constitutes the proper tissue of the ovary. It lies immediately beneath the tunica albuginea, and fills up the whole of the intermediate space between the ovisacs, to which it acts as a germ bed, protecting the ova from injury, and serving for the conveyance of blood-vessels to the ovisacs. This tissue is sometimes of a pale-pink, but more often of a bright-red colour, from the large number of blood-vessels which it contains, whose arrangement proceeding from within, and radiating outwardly in all directions, gives to this tissue, when viewed by the naked eye or by

Fig. 371.

Ovary enlarged four diameters. (*After Coste.*) *Dissected to shew,*

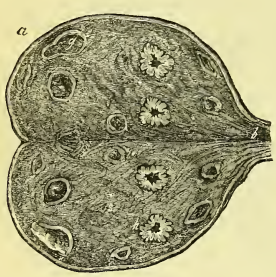
A, peritoneum; B, tunica albuginea; C, stroma; DDDD, Graafian follicles in various stages of growth; EE, outer coat of the follicle (tunic of the ovisac); FF, inner coat of the follicle (ovisac); GGG, epithelial lining (membrana granulosa); HH, ovum and cumulus; I, orifice by which the follicle has discharged an ovum; K, Fallopian tube; L, fimbriæ; M, posterior ala of broad ligament or mesentery of ovary; N, tubo-ovarian ligament; O, ligamentum ovarii.

a common lens, the appearance of being formed into bundles or laminæ.

The microscope, however, serves to resolve this tissue into its true elements. When so examined, the stroma is found to be composed mainly of blood-vessels, to which a great part of its strength and toughness is due, the intermediate spaces being filled up by a fibrous structure not separable into bundles, like ordinary connective tissue, and having no distinct fibrillar arrangement, its chief elements being single white fibres of ordinary connective tissue, numerous fusiform embryonic fibres, and elliptical and round cells or granules, the whole being coherent and strongly united together.

3. *The Graafian Vesicles. Folliculi ovarii, s. Graafiani, s. Ovisacci.*—When the substance of a healthy ovary is divided by a clean incision, if the subject be not too advanced in life, the section will be found to have included several vesicles varying in diameter from 4‴ down to sacculi of microscopic minuteness. These

Fig. 372.



Longitudinal section of adult ovary. (*Ad Nat.*)

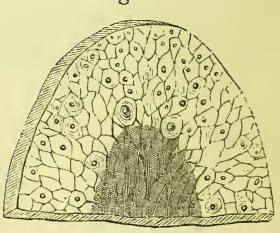
a, distal; *b*, proximal end; *s*, stroma; *g*, Graafian follicles of the ordinary size before enlargement; *h*, stellate remains of follicles which have burst and shrunk after discharging their ova.

vesicles, familiarly known as the ova of De Graaf, although the credit of antecedent observation is certainly due both to Vesalius * and Fallopius †, are variously distributed through the ovary according to the age of the individual. In infants and young subjects, the ovisacs are found only at the periphery of the organ, where they form a thick rind, the interior of the ovary being occupied only by blood-vessels and stroma. But after puberty the division into a cortical and central part becomes less distinct, the ovisacs becoming buried deeper in the stroma, so that occasionally, in making sections of the part, they are encountered as deep as the base of the organ. They are always, however, most numerous near the surface.

The number of developed vesicles contained in each ovary, and visible to the naked eye, varies considerably in different subjects. Up to a very recent date it appears to have been assumed that their number was limited. They were usually estimated at 12 to 20 in each ovary; and it was generally supposed that, when these were exhausted by child-bearing and miscarriage, the power of procreation of necessity ceased. More recent and careful observation, however, has shown that the number of vesicles in each ovary amounts in healthy organs to 30, 50, 100, or even 200; whilst in very young subjects their numbers exceed all power of accurate computation.

The vesicles are most easily displayed in the adult ovary by making a perpendicular section through the organ in the direction of its longer axis. In this way the largest number will have been divided by one incision; and such a section, as in *fig.* 372., will often suffice to exhibit 8 to 12 vesicles of different sizes. On submitting the section, however, to the microscope, others of a smaller size, which had previously escaped attention, will be brought into view; and in continuing the incisions in various directions, fresh vesicles will be laid open of various sizes and in different stages of development. If the ovary of an infant be selected for observation, the organ should previously have been hardened by maceration for several days in spirit. A clean section is thus easily obtained by a sharp knife; and if this be examined by a 1-inch object glass, the little spherical ova, coagulated by the action of the spirit, will be readily seen, each one lying in its proper ovisac, by which it is immediately surrounded, and the whole so closely set and so numerous that a single section suffices to display several hundred of them at one view (*fig.* 373.).

Fig. 373.



Section of part of the ovary of an infant, aged 20 months. The central portion consists of stroma and blood-vessels only. The lighter peripheral part is composed entirely of close-set ovisacs, containing ova of various sizes. (*Ad Nat.* × 16 *diam.*)

The Graafian follicle, when not subjected to pressure from surrounding parts, or from adjacent vesicles, is spherical or oval in form, (*fig.* 371. DD, and *fig.* 372. *g*) and consists of certain tunics and contents. The number and composition of its coats have been variously described by recent observers; and upon this subject a difference of views would be of comparatively little importance, if upon a right solution of this question did not depend the clear comprehension of those changes which occur in the Graafian follicle during preg-

* De Corporis humani Fabrica, lib. v. cap. xv. p. 459.

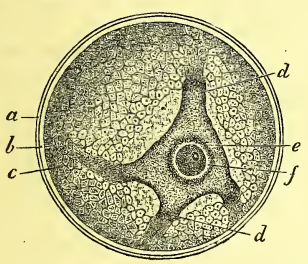
† Obs. Anat., Op. omnia, 1606, vol. i. p. 106.

nancy, and which result in the formation of the body termed the *corpus luteum*.

Without entering upon the question of the number of laminæ into which the walls of a Graafian follicle may be split by skilful manipulation, it will suffice to consider those only as distinct membranes or coats, which exhibit obvious differences of structure and relationship, during the various phases of development and decay which the follicle undergoes from its first formation to its final disappearance. In this view the walls of the Graafian follicle must be regarded as being composed of three membranes; and indeed but for the importance attached to the use of the third or innermost of these, which in any case is hardly more than a thin layer of granules, it would have sufficed if the coats of the vesicles had been enumerated as two only.

The external fibrous or vascular coat (*fig.* 374. *a*, *fig.* 371. E) constitutes the *tunic of the ovisac* of Barry, the *tunica fibrosa*, *S. theca folliculi* of Baer. It forms no portion of the original ovisac, but is a superadded part, derived from the parenchyma of the ovary. This coat closely embraces the ovisac, and partakes

Fig. 374.



Graafian vesicle of the rabbit × 100 (?) *diameters.* (*After Barry.*)

a, outer coat or tunic of the ovisac; *b*, ovisac; *c*, epithelial lining or membrana granulosa, a portion of which has been removed in order to display *dd*, retinacula (here too distinctly marked); *e*, tunica granulosa of Barry immediately surrounding the ovum, consisting of, *f*, zona pellucida, within which is the yelk and germinal vesicle and macula.

in its spherical figure; it carries numerous blood-vessels, which pass from the ovarian stroma to become expanded in a vascular network over its walls (*fig.* 371. D).

Examined by the microscope, this membrane is seen to be highly vascular. It is composed of a fine membrane, containing few fibres, but everywhere abundantly studded with oval nuclei, visible without the aid of acetic acid, and probably, in part at least, due to the presence of so many blood-vessels in its tissue. This coat contains no oil globules. Its chief use appears to be to give increased support and protection to the true ovisac which it surrounds, and to convey blood-vessels from the ovary for its nutrition, and for the supply of the fluids which the ovisac contains.

The second or internal coat, as it is commonly termed, of the Graafian follicle is the ovisac itself. It constitutes at first an independent structure; but receiving afterwards the before mentioned investment from the ovarian parenchyma, the two coats unite to form the Graafian follicle. The ovisac is

Fig. 375.

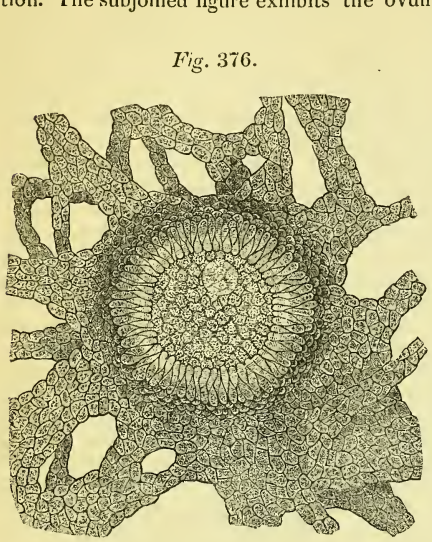
Structure of ovisac. (*Ad Nat.* × 350.)

composed of embryonic fibres of connective tissue (*fig.* 375. *a*), of rounded cells or granules, *b*; and of a large proportion of minute oil globules, *c*. The embryonic fibre-cells lie parallel with each other, and together with the granules form the bulk of the tissue in nearly equal proportions. The oil drops are very numerous; and after the preparation has been under examination for some time they are seen to float up to the surface of the drop of water in which it is placed, and to collect upon the under side of the glass disc used for covering it. In addition to these there is found a small quantity of developed fibres of connective tissue, which appear to give firmness to the whole. The Graafian follicle thus composed, contains, in close contact with its inner wall, a stratum of nucleated cells, forming an epithelial lining, termed the *membrana granulosa* (*fig.* 374. *c*, *fig.* 371. G). The cells or granules which give a name to this membrane are so lightly held together that it has been doubted whether the stratum which they form is really entitled to the denomination of a membrane. Nevertheless this structure appears to play an important part in regard to the ovum, which is always found lodged within a portion of it. At the commencement of the formation of the ovisac, according to Dr. Martin Barry, these peculiar elliptical nucleated cells or granules are nearly equally diffused through the fluid which it contains, the ovum lying in their centre. But about the time at which the ovisac unites with its covering or tunic to form the Graafian follicle, these granules are found to have become separated into little groups, leaving interspaces filled by fluid. Further, as this separation advances, the granules arrange themselves in such a manner as to constitute three distinct structures. The principal portion collects upon the inner surface of the ovisac forming the *membrana granulosa* just described (*fig.* 374. *c*). A second portion becomes aggregated upon and around the ovum, taking its form and constituting a special investment for it. This is the *tunica granulosa* of Barry (*fig.* 374. *e*). A third portion collects to form a structure composed of a central mass in which the ovum with its tunica granulosa is imbedded, corresponding with the *cumulus* (*fig.* 371. H,H) of Baer, and of certain cords or flattened bands, from two to four in number, which pass off from the central mass outwards, to become united with the layer of granules lining the follicle. These radiating bands or cords are termed by Barry the *retinacula*, (*fig.* 371. *d d*)

from their supposed office in suspending the ovum, and retaining it in its proper situation in the Graafian follicle.

That the *retinacula*, however, are not essential structures is proved by the fact that they are wanting in many of the Mammalia as well as in Man. They have been observed chiefly in the Rodentia and Ruminantia, where their form and number are subject to considerable variation. The subjoined figure exhibits the ovum

Fig. 376.



Ovum of rabbit surrounded by the tunica granulosa and portions of retinacula. (After Coste.)

surrounded by the layer of granules which constitutes the *tunica granulosa*, and externally to this the radiating bands or *retinacula*, the whole of those parts, external to the ovum, being composed of nucleated cells.

Besides these structures, the Graafian follicle contains a pellucid albuminous fluid, of a slightly yellowish colour, partially coagulable by heat. In this fluid float numerous granules similar to those of which the parts just described are formed, together with a varying quantity of oil-like globules.

Lastly, in the midst of the granules at an early period, and subsequently in that more definite arrangement of them which constitutes the *tunica granulosa*, is contained the ovum (*fig.* 374. *f*, and *fig.* 376.), a full description of which is given in the article under that title.

4. *Vessels and Nerves.*—The ovary derives its supply of blood chiefly from the ovarian (spermatic), but in part also from the uterine arteries. So free, indeed, is the communication between these vessels, that the organ may be equally well injected from either source. The communication is effected chiefly by means of a branch of the ovarian artery, which passes inwards to inosculate with a terminal branch of the uterine artery, this anastomotic branch being occasionally so large as to constitute the principal source of supply of the ovary. The terminal vessels are conducted to the lower border of the ovary between the folds of the posterior duplicature of the broad ligament, where they lie in parallel lines, and are readily distinguished by their tortuous or spiral form. Having entered the base of the organ, they spread out into those numerous ramifications which penetrate every part of the ovarian stroma, and give to this structure its peculiar fibrous aspect. From their extreme branches the blood is returned by the veins, which pass to the base of the organ, where they are very numerous (*fig.* 370. *h*). They form, near the ovary and between the folds of the broad ligament, a plexus termed the ovarian or pampiniform plexus, (*fig.* 369. *d*) the vessels of which communicate also with the uterine plexus. Valves are found in the ovarian veins only in exceptional cases.

The ovary derives its nerves from the renal and inferior aortic plexuses.* The nerves enter the organ along with the blood-vessels.

Functions of the Ovary.

The ovary is to the female what the testis is to the male—the germ-preparing organ, the part in which is formed the female generative element, and therefore the essential portion of the entire sexual apparatus. To it all other structures may be regarded as accessory or superadded; for in by far the largest proportion of the animal kingdom they are either found in a rudimentary state, or else have no existence. But not only is the ovary the organ in which the formation and evolution of the germ take place; its offices farther extend to the separation and expulsion of the ova, when they have reached such a state of maturity as will render them susceptible of impregnation. This process, commonly termed ovulation, takes place spontaneously, and without the intervention of the male, which is not necessary thereto. All animals possessing an ovary are subject to this law; and Man constitutes no exception to the rule. But the functions of the ovary are exercised only during a certain period of life. The ova, which are formed at or near the time of birth, and sometimes before that event, are not called into activity until the body of the parent is sufficiently developed, to suffer the parturient act without destruction or serious detriment to its own tissues, such as would be incompatible with the continuance of its own life, and such as is witnessed in those lower tribes where the whole of the vital energies of the parent are exhausted by one effort of reproduction, or its tissues are even disrupted by the process which produces its kind. But long before the time arrives at which the generative faculty is capable of being fully exercised, it is probable that many of the ova which were first formed have perished, their place being continually supplied by new formations.† Their numbers, however, are so great that, if only the one thousandth part of those originally contained

* Snow Beck, Phil. Trans. 1846, part ii.

† Barry, Phil. Trans. 1838, part ii. p. 319. Dr. Ritchie, Med. Gaz., vols. xxxiii., xxxiv.

in the ovary remain, and no new ones are superadded, there will still be more than sufficient for all the purposes of reproduction. But as the functional activity of the ovary, so far as relates to the emission of ova in a state fit for impregnation, is restrained on the one side until the arrival of a certain stage of development of the parent, so on the other a period equally arrives, after which this power of producing and emitting ova altogether fails; and it is plain that both these restrictions contribute to one and the same end, the limitation, namely, of the office of reproduction to that period of life in which the vital energies of the producing body, having attained to full perfection, remain still unimpaired, so that the qualities of health and vigour in the parent may be transmitted undiminished to the offspring.

From this it results that the ovary in Man, as well as in the Mammalia generally, has three noticeable periods: the first, of preparation; the second, of activity; and the third, of decay: and these correspond respectively with the periods of infancy and childhood, of youth and prime, and of decline and old age.

The condition of the ovary at each of these epochs will be traced; but the middle period is obviously that to which the chief interest attaches.

During certain portions of this epoch, and in some instances through more or less of its whole extent, the ovary is employed in ripening and emitting ova. In this respect, however, greater variation is perceptible in different species than in any other particular. But in all alike this one circumstance is observable, namely, that the emission of ova is a periodic occurrence.

Now the periods of emission of ova may so occur as to make the times of parturition coincident with the returns of those seasons which are most favourable for the rearing of the young. In such cases the capacity for impregnation may be limited to one period of the year, the ova being ripened and emitted only at that time. The roe affords an interesting example of this. The doubts which have been sometimes entertained as to the precise time at which the roe becomes impregnated have now been settled by the recent very careful researches of Bischoff*, who has proved that this occurs at the end of July and during the month of August, and that it is only then that the ovaries of the female contain ripe ova, and the testes of the male ripe semen. At other times these are not to be found; hence it follows that in this animal impregnation is impossible at all other seasons.

But in many animals the periods of ripening and discharge of the ova recur with much greater frequency; and probably climate, food, domestic care and the like, exercise a certain degree of influence in modifying the returns of these periods.

In the human female the same periodicity is observable; and it is now rendered in the highest degree probable that in her case the times of ripening and generally of the discharge of the ova are coincident with the times of menstruation*, just as it has been proved beyond dispute that in other Mammalia the same process accompanies that more obvious condition of aptitude and desire for sexual intercourse to which the terms œstrus and rut are applied.

A periodical maturation, therefore, of ova, accompanied by dehiscence of the ovicapsules and discharge of their contents, may be said to constitute the principal offices of the ovary during the prime of life. But notwithstanding that these processes are periodically performed, the ovary cannot at any time be said to be in a condition of perfect rest, except under circumstances which will be presently noted; for whilst some ovisacs may be observed to be advancing and preparing to emit ova, others may be seen receding or becoming obliterated. The climax, however, of each serial process is the dehiscence or rupture of one or more follicles. Upon this the whole force of the ovary is, as it were, for the time concentrated. This event being terminated, the activity of the ovary passes away as regards that particular follicle. Enough, however, of vital energy remains in the now useless part to suffice for the healing of the wound, and the closing and obliteration of the cavity left after the escape of the ovum. But the blood gradually deserts the walls of the previously congested ovisac, the distended vessels in its neighbourhood shrink and become obliterated, and the action is transferred to another set of follicles, one or more of which pass through a similar order of changes.

Two circumstances, however, arrest for a time this process. The one is the occurrence of utero-gestation, the other the performance of lactation; and although occasional exceptions may be observed, yet so far as this question has been examined, the evidence collected favours the belief, that in pregnant women and in those who suckle, no ova are emitted during the continuance of either of these processes.†

This view also, so far as relates to lactation, receives support from the well-known circumstance that a considerable degree of immunity from impregnation occurs during the continuance of lactation, a circumstance easily explained upon the supposition that at that time usually no ova are matured or emitted.

It will now be necessary to trace in detail the process of ovulation, so far as regards the structures concerned in that process which properly belong to the ovary.

A general account of the Graafian follicle in its mature state having been already given at p. 550., the changes which this important structure undergoes at different periods of its development and decay will now be examined.

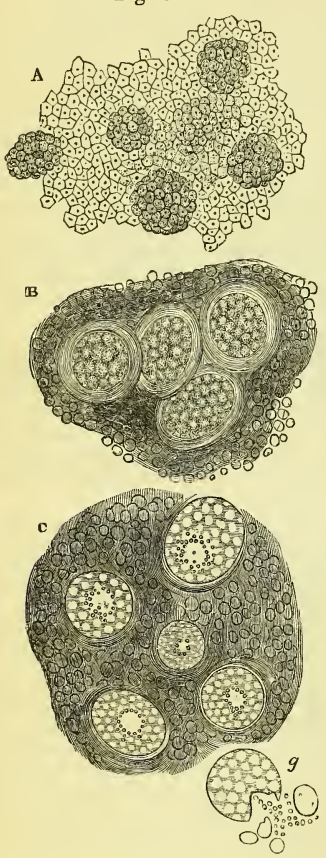
* Entwick. des Rehes, 1854.

* The question of the connection between menstruation and the maturation and discharge of ova from the ovary, is considered under the head "Menstruation" at page 666.

† Négrier, Recherches sur les Ovaires, chap. ii. iii.

First Stage. Origin of the Graafian Follicle.—The time of the first appearance of the follicle within the ovary is subject to considerable variation in the different orders of Mammalia. In all it occurs at a much later period than the first appearance of the seminiferous tubes in the male. Bischoff, who has devoted much attention to the examination of the follicle in its earliest stages of formation, has never been able to discover the least trace of it in the dog and rabbit before birth. This is also the case in most instances in the human embryo, although examples occur of the ovarian follicles being already formed in the new-born infant, and in advanced embryos. At first nothing is distinguishable in the ovary except a uniform mass of primary cells and cell nuclei. When the follicle or ovisac is about to form, there may be perceived little round or ovoidal aggregations of primary cells, forming groups which are distributed in considerable numbers through the ovary. These, from the circumstance that the substance of the ovary is likewise composed of similar cells, are scarcely distinguishable from the stroma in the midst of which they arise (*fig.* 377. A).

Fig. 377.



Represents the mode of formation of the Graafian follicle. (After Bischoff.)

A, portion of ovary of a fœtal dog. The Graafian follicles are seen in the first stage of formation, consisting of little groups of primary cells in the midst of a tissue of similar structure.

B, Portion of ovary of a dog four weeks old; a delicate fibrous coat now surrounds the groups of nucleated cells.

C, Portion of ovary of a pig three weeks old. The follicle is here composed of transparent membrane, the outer surface of which, in the larger ones, is become fibrous. Its inner surface is lined by an epithelium of pale cells (membrana granulosa); within this is the germinal vesicle, surrounded by granules resembling yelk granules. These contents are seen dispersed from a ruptured follicle at *g*.

Now Barry, who also very carefully examined the early formation of the follicle in the rabbit, maintains that within these little groups of cells the germinal vesicle is already contained. Barry represents the germinal vesicle at its first formation as surrounded by minute oil globules, and a collection of granules, forming together little elliptic masses which are distributed through the ovary. A comparison of the descriptions and illustrations of these two observers leaves no doubt that both refer to precisely the same object.

Round these little groups of cells is now perceived a delicate transparent membrane, which is at first apparently destitute of organisation. This is the ovisac in its first stage of formation (*fig.* 377. B, C). The precise mode of its development has given rise to much speculation, which is interesting chiefly with reference to the question whether the ovisac is to be regarded as the vesicle of evolution of the ovum, or whether the ovum, or parts of it at least, are previously formed, and the ovisac is afterwards superadded.

Bischoff explains the formation of the fine homogeneous membrane which is first seen surrounding the little groups of cells by supposing that those which form the peripheral layer become confluent, and that by their junction they constitute this boundary wall, whilst the original cell contents are dispersed.

This membrane soon afterwards becomes lined with a stratum of endogenous cells, which form an epithelium upon its inner surface. A close examination shows further that this cell layer is bounded by a homogeneous tunica propria.

Hence Bischoff concludes that the follicle is, as Henle asserts, a primary secreting follicle, which, like all secreting follicles, is not composed of a primary cell membrane, but results from a confluence of cells. He has never seen in it, when still in the condition of a homogeneous transparent membrane, a cell nucleus, as would be the case in a primary cell. The contents of the vesicle, according to Bischoff, consist of a clear fluid containing cell nuclei and granules; the latter closely resembling the subsequently-formed yelk granules. Somewhat later is observed within these follicle vesicles, which in the meantime have become more developed and numerous, a second transparent spherical vesicle, containing a nucleus which closely resembles, and is considered by Bischoff to be the germinal vesicle. Hence, whilst the observations of Barry, confirmatory of the views of Baer, and supported

now by Dr. Allen Thomson*, led the former to conclude that the formation of the ovum commences before the existence of the ovisac, the researches of Bischoff point, on the other hand, to the ovisac itself, as the formative organ of the ovum.

The general appearance of the ovisac, when first formed, is that of a pellucid, and often yellowish vesicle, having an elliptic form, and at first so minute as not to exceed $\frac{1}{50}$—$\frac{1}{100}$‴ in diameter; as, for example, in the ox, the ovary of which animal, according to Barry, would contain in a cubic inch 200,000,000 of such ovisacs.

The ovisac is more or less pellucid, according to its size. In the smaller ones, the walls are so transparent as to admit of the form of their granular contents being seen through them (*fig.* 377. B, C); but as development advances, they become merely translucent. The walls, which are relatively very thick in the small ovisacs, are elastic and distensible, and have an undulating surface, presenting numerous depressions, to which is referable the plaited or folded appearance which the contour of the ovisac assumes under pressure.

The ovisac is sometimes formed in the parietes of an already developed Graafian follicle; but whether originating here, or, as is more commonly the case, in the proper substance of the ovary, it is always at first seen lying perfectly loose in a little cavity, excavated, as it were, in the substance of the surrounding tissues. Subsequently a covering, or tunic, consisting of a rather dense connective tissue, susceptible of becoming highly vascular, and closely connected with the ovarian stroma, is gradually formed upon the outer surface of the ovisac, with which this outer covering now becomes closely united. This is the structure termed by Barry the tunic of the ovisac (*Tunica S. theca folliculi*). And it is by the union of these two that, according to his observations, the Graafian vesicle is formed. At this stage of its development there exist all the elements of the completely-developed follicle, viz., the outer vascular or fibrous coat, the inner softer layer, or proper tunic of the ovisac, and the still more internal epithelial layer of granules representing the membrana granulosa, together with the elements, at least, of the ovum, and the fluid contents of the sac.

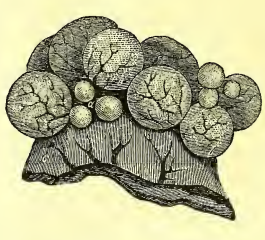
These constitute the most important points regarding the development of the Graafian follicle at the time of its first formation in the Mammalia generally. They serve to facilitate greatly the study of the same parts in Man.

With regard to the human follicle, the corresponding stage is most readily observed in the infant, a few months after birth. If at that age a section be made of the ovary, it will be seen to be composed of a parenchyma, which is somewhat lax towards the centre and base, but more dense in the peripheral portion of the organ. The more lax central portion consists of blood-vessels and wavy bundles of connective tissue, the latter being much more distinct in the ovary of the infant than in the adult. The more dense peripheral portion is that in which alone the ova are found. It is made up almost entirely of a mass of minute ovisacs, already containing ova (*fig.* 373.).

These ovisacs, at present in a rudimental condition, are of various dimensions. In the example given, their average diameter was $\frac{1}{500}$—$\frac{1}{1000}$″. But it happens, occasionally, that ovaries of a very early age are found to contain ovisacs or Graafian follicles of comparatively large size. Thus, in a specimen in my possession from a child of seven months, one ovary contains a follicle of rather more than 1‴ in diameter, whilst the other is almost entirely occupied by five follicles, the largest of which measures $2\frac{1}{2}+1\frac{1}{2}$‴, and the smallest is one quarter of that size. In this case the entire length of the ovary is only 7‴.

Second Stage. Growth, Maturation, and Preparation for Dehiscence of the Follicle.—When the period approaches, or has already arrived, at which an animal becomes apt for reproduction, and is ready to receive the male, a certain number of follicles progressively increase in size, and become more and more superficially placed. Shortly, the more advanced series occupy the surface of the ovary, and present the appearance of round grains close-set, so as to give to the organ sometimes the appearance of a bunch of grapes (*fig.* 378.). This is more particularly the case in the sow, which affords an excellent example for tracing these changes in the follicle.

Fig. 378.



Portion of ovary of the sow. The Graafian follicles project above the surface of the ovary. Several, riper than the rest, are conspicuous by their size. a, unripe; b, riper follicles; c, stroma.
(*After Pouchet.*)

Each grain, *a*, consists of a vesicle filled with a limpid fluid, albuminous, viscid to the touch, of a slightly yellow colour, and coagulable by heat and alcohol. Their walls, previously diaphanous, now become opaque from the thickening of the *inner* membrane of the vesicle, *i. e.*, of the ovisac itself. From four to six of these vesicles will be found to become simultaneously developed in each ovary (*fig.* 378. *b*,*b*). These are always the most superficial. Their form is generally ovoid. They increase until they attain a diameter of about $\frac{4}{5}$″.

* Page 76. of this vol., Supplement.

The augmentation in bulk of the follicle is, in the first instance, due almost entirely to an increase in its fluid contents. It is probable that this fluid is supplied by the minute capillaries with which the ovisac is furnished, and which, long before the vesicle has attained its full diameter, appear in the form of a rich network upon its inner surface, giving to the latter a bright red colour.

And now a thickening of the walls of the follicle becomes very manifest, accompanied by an exudation of blood which collects in the interior of the sac. The period at which this escape of blood commences is variable. Sometimes it may be seen in follicles of not more than $1\frac{1}{2}'''$ diameter, but more frequently when they have attained a size of about $3'''$.

As this exudation of blood takes place at a period certainly antecedent to the rupture of the follicle, it cannot be traced to vessels lacerated during that process, but must proceed from the congested capillaries just described. It resembles arterial blood, and is rich in globules, which at first remain free and distinct; but when the distension of the follicle has become considerable, the blood coagulates into a dark-red clot.

This pouring-out of blood has been termed the menstruation of the follicle; but beyond the purpose of increasing the distension of the latter, preparatory to its rupture, no use has been assigned to it, except by Pouchet, who maintains that in the sow the ovum lies at the bottom of the follicle, instead of near its upper or free surface; and that as the sanguineous exudation increases, it collects between the inner surface of the ovisac and the membrana granulosa, and so carries upwards the latter, together with the ovum which is lodged upon it. He asserts, further, that in proportion as this exudation increases, the albuminous fluid previously occupying the follicle is absorbed, until the entire cavity becomes filled with blood.

The result of this process is, that the ovum, previously lying at the bottom, is now transported to the upper part of the follicle, immediately beneath the point at which the rupture of the walls is about to take place.

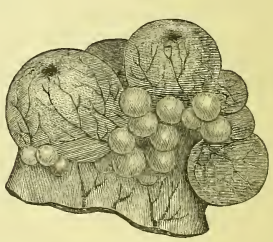
Notwithstanding the minuteness of Pouchet's description, its accuracy, so far at least as concerns the supposed purpose of this exudation of blood, has been called in question. The fact, however, cannot be disputed, that, in many animals, as well as in man, the follicle does contain blood, often in considerable quantity, previous to its rupture. And this is a very important point, because it serves to refute the statement of some who maintain that the presence of blood, or of a clot, within the follicle, affords certain evidence that the rupture of the latter, together probably with the escape of the ovum, has already occurred. Barry also, in his researches upon the rabbit, says, that after certain of the ovisacs have discharged their ova, "some of the larger Graafian vesicles, remaining unbroken, are frequently found to contain a considerable quantity of blood. Such spots, he observes, have been noticed by several observers, who supposed them to indicate the Graafian vesicles from which ova were destined to be expelled.

Thus Barry's prior testimony serves to confirm that of Pouchet and others, to the effect that the blood found within the follicle does not result from its rupture, but that it is there antecedent to that process.

Some other changes which occur in the follicle previous to its rupture may here be noticed. The thickening just spoken of takes place in the inner membrane, or that which constituted originally the ovisac. This thickening is sometimes so considerable as to increase the diameter of the follicular walls to three times their original amount. At the same time, their contour becomes somewhat undulating, and their colour approximates to that of the buffy coat of the blood.

While these changes are going on in the substances and in the contents of the follicle, preparation is being made externally for the rupture at a certain part of the parietes. The base of the follicle continues to be imbedded in the substance of the ovary (*fig.* 379.), but the upper portion projects free above this, being covered only by the usual ovarian investments. Here, at the more salient portion of the projecting vesicle (*fig.* 379.), an increased vascularity is observable. The peritoneum and sublying tissues become exceedingly red, and an abundance of blood is observed in the numerous capillaries which are now visible upon the summit of the vesicle. After this, the fibres of the ovarian coverings become gradually separated, preparatory to their complete laceration. The tunics also of the follicle itself become perceptibly thinner at this spot, which corresponds with the situation of the ovum — always, at this period, lying immediately beneath it.

Fig. 379.

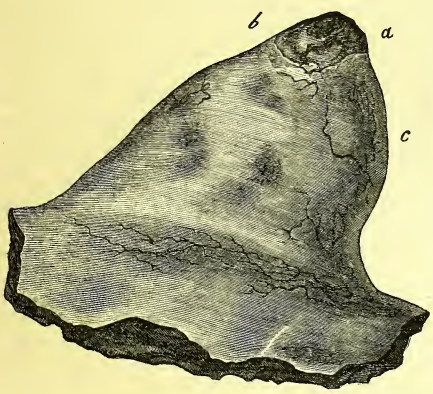


Portion of ovary of the sow. The follicles are in a more advanced stage than in fig. 378. *Two of these are preparing for rupture. Already a small aperture is perceptible in the centre, immediately above the spot where the ovum lies; and towards this point the bloodvessels converge.* (*After Pouchet.*)

The same regular sequence of changes, which may always be traced in the Mammalia, though with some slight variations according to species, occurs also in man. If the examination be made in a young and previously healthy woman, who has menstruated regularly up to the time of her death, there will gene-

rally be found in the ovary one or more follicles in conditions similar to those just described. The ordinary state in which the Graafian follicle is found has been explained at p. 550. Vesicles in the state there described may be seen at all times in the healthy ovary, sometimes near its surface, and at others buried more deeply; but when they increase in growth beyond this size, and are preparing to rupture, one or more will always be found approaching the periphery of the ovary, or rising above the level of its outer tunics, constituting there a nipple-like prominence, so distinct as at once to arrest attention, and to point out the part of the ovary in which the dehiscence will next occur (*fig.* 380. *a*).

Fig. 380.



Ovary from a woman aged 22, *who died on the tenth day after the commencement of her last menstrual period.* (*Ad Nat.*)

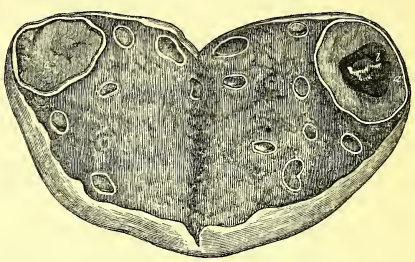
A follicle is preparing for spontaneous rupture at *a*, where a considerable prominence occurs, and where the peritoneal and albugineous coats are almost entirely absorbed.

In general, only one follicle will be found preparing for rupture; but sometimes two, or possibly three, may be observed in the same condition in one ovary. The growth has now been so considerable, that instead of measuring only $1\frac{1}{2}'''$—$2\frac{1}{2}'''$, or even $3'''$, it has now a diameter of $5\frac{1}{2}$—$7'''$, the breadth being usually somewhat less than the length, for it rarely happens that the follicle is perfectly spherical. In consequence of this increased growth the follicle projects from the surface, and causes the swelling just described, whilst the accumulation of fluid within it produces a softness and sense of fluctuation in this part of the ovary, which is very obvious to the touch. Over the centre of this projection the peritoneum is exceedingly thin, and in some places is wanting, partly from absorption, and partly from laceration, the result of overstretching and distension.

The tunica albuginea also of the ovary may be absorbed, or may have become so exceedingly thin, as to permit the blood-coloured contents of the vesicle partially to appear through it, giving to the spot a peculiar brick-red colour. Around the margin or base of the prominence the fibres of the tunica albuginea are often seen to be separated at short distances, forming concentric lines or interrupted circles; the red contents showing through the interspaces, and producing an appearance of alternate white and red lines (*fig.* 380. *b*). Beyond this circumference, the base of the prominence exhibits the usual white colour of the ovarian coverings. Numerous red vessels, chiefly veins (*fig.* 380. *c*), ramify towards the projecting spot, and some of these traverse it to its summit, coursing over the prominence in serpentine lines, and forming here a rich plexus.

A clean section through the centre of the projecting follicle lays open an ovoid cavity,

Fig. 381.



The same ovary (*ad Nat.*) *as in fig.* 380. *laid open, displaying,*

a, the cavity of the enlarged follicle; *c*, the corresponding half of the same; *b*, a blood-clot. Numerous follicles of the ordinary size are seen scattered through the ovary.

(*fig.* 381. *a*), containing usually a deep red clot, *b*, together with a certain quantity of blood and a bloody fluid. The clot has as yet no adhesion to the walls of the cavity, and is easily washed away.

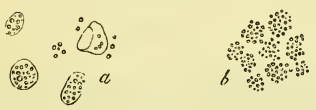
If the ovary has been examined not too long after death, the ovum may possibly be found lying imbedded in the granules of the *membrana granulosa*, immediately beneath the most projecting point of the follicle. But more commonly, the examination not being made until after this delicate membrane has melted down, and its granules have become dispersed by post-mortem change, the ovum cannot be discovered.

After washing out the contents of the follicle, the inner surface of the ovisac is exposed (*fig.* 381. *c*). This I have occasionally seen to be of an intense red colour, from the surface being covered by a rich network of capillaries filled with blood. But most commonly the colour of the ovisac throughout, as far as the outer tissue of the follicle, is at this time a clear, pale, chrome yellow, this coat being now also very soft in texture. It is important to observe that the yellow colour includes the whole thickness of the ovisac, or inner coat of the Graafian follicle, which now measures from $\frac{1}{3}$ to $1'''$ in thickness, but that it extends no further; the outer coat, or theca

folliculi, retaining its ordinary condition. Already a slightly wavy outline is perceptible in the follicle (*fig.* 381.), which is due to the growth of the inner membrane having continued after the outer coat has ceased to expand.

The inner coat of the follicle, when it has thus acquired a yellow colour, is seen, by the aid of the microscope, to have undergone an important and yet very simple change. On its inner surface, or that which is turned towards the cavity of the ovisac, it presents the appearance of a transparent and nearly structureless membrane, in the substance of which are imbedded numerous oil droplets, very minute, and aggregated in little masses,

Fig. 382.



Cells filled with oil-granules which give the yellow colour to the inner coat of the Graafian follicle before it has burst, forming the substance termed corpus luteum. (*Ad Nat.* × 350.)

a, separate cells; *b*, the same imbedded in the structureless membrane. (From the same subject as *figs.* 380. and 381.)

with a certain regularity which suggests the idea that they have either been originally deposited around a centre globule, or are contained in cells or vesicles, the cell-wall of which is not very discernible (*fig.* 382. *b*). Deeper towards the outer surface of the ovisac the oil droplets or granules become so numerous as to prevent the recognition of any other structure until the greater portion of the oil has been dissolved out by macerating the part in ether. If, after this process, the tissue which remains be washed in spirit or water, and subsequently treated by acetic acid, it is seen to be composed of numerous blood-vessels, and of developed as well as embryonic fibres of connective tissue, which latter, however, are only faintly indicated, and are connected together by a transparent membrane. The proportion of developed fibres of connective tissue is here very large, whilst in less advanced follicles the embryonic fibres preponderate (*fig.* 375.).

Another and perhaps more satisfactory mode of examining the yellow coat of the Graafian follicle in this stage, consists in slow maceration in a very weak preservative fluid (glycerine and water). The cells, which this coat contains in great abundance, can now be obtained separately for observation. They are seen to consist of a transparent cell-wall, filled with oil granules (*fig.* 382. *a*). The average cells vary in diameter from $\frac{1}{800}''$ to $\frac{1}{2000}''$, but many are smaller, and others larger. Occasionally a cell may be seen to have burst, its contents having escaped; a few oil granules, however, may still be perceived adhering to the cell-wall, the torn margins of which are very readily defined. There can be no doubt that these cells are the "peculiar granules" so frequently described and figured by Barry in his account of the various conditions and stages of development of the ovisac.

The colour of the yellow coat—the so-called *corpus luteum*—is not alike in all animals. In some of the Mammalia it is of a bright orange; in others it inclines to red. In Man, as already stated, the inner surface of the follicle, when ripe, is occasionally so loaded with bright red capillaries that the usual appearance is obscured, but its ordinary aspect presents the clear chrome yellow just described. That this yellow colour, like that of the yolk of the bird's egg, is due to the presence of the oil globules (*fig.* 382. *b*) which everywhere penetrate the tissues of this coat, is rendered sufficiently apparent: first, by the fact that treatment by ether, which dissolves out the oil granules, leaves the remaining membrane nearly white; and secondly, that maceration in water has, to a certain extent, the like effect, but in this case arising from the maceration, causing the animal membrane to swell and become opaque, thus obscuring its previous transparency, and rendering the oily portions only faintly discernible through it, as judged by the naked eye, though they are still readily discoverable under the microscope.

Third Stage. Period of Rupture or Dehiscence of the Follicle, and Escape of the Ovum.—This is termed by Pouchet the period of parturition, in which, after the preparatory changes already described, the ovum quits the Graafian follicle in order to enter the Fallopian tube. It is therefore for the ovisac what the process of parturition is for the uterus, viz., the act by which the ovum, after being matured to a certain point of perfection, is expelled from its cavity.

The process by which the dehiscence of the follicle is effected in Mammalia is in some respects different from that which causes the expulsion of the ovum, from its containing capsule, in the vertebrata below them. In birds, reptiles, and fishes, and, indeed, in the Invertebrata generally, the ovum is of so large a size in comparison with the ovicapsule, that the simple increase of the former, as the time of the ovipont* approaches, is sufficient to cause the bursting of the sac at the point where the coats have been prepared for rupture by previous attenuation. But in the Mammalia the bulk of the ovum bears so small a proportion to its containing follicle, that the ovum itself contributes in no degree to the rupture by which it is enabled to escape. In this process it remains a passive body, at least in a mechanical point of view, though doubtless it is the perfecting of the ovum which gives the vital impetus to that series of changes by which it is finally released from its first abode. But the act of

* I have anglicised the French term *oviponte* (ovipont), to express the escape of the ovum from the ovary; while "ovulation" is employed, in a more general sense, to include also the process of its maturation.

parturition is accomplished by other means. The process by which this is effected has been compared by Blumenbach to the spontaneous bursting of an abscess. Here the process consists in an increasing accumulation of fluid within, conjoined with a gradual attenuation of some particular part of the containing walls. So many points of similarity, indeed, may be traced between these two processes, that the term "inflammation" is employed by some authors in describing the preparatory changes in the Graafian follicle.

The resistance which the ovum and other contents of the vesicle require to overcome before any portion of these can escape consists, it must be remembered, in the combined opposition of no less than four membranes, in addition to any portion of the proper ovarian stroma which may intervene. These are, first, the ovisac; then its capsule, united to the former, and with it constituting the Graafian follicle; thirdly, the tunica albuginea; and fourthly, the peritoneal covering of the ovary. These four, shortly previous to the rupture, become so intimately united together that it is no longer possible to separate, nor is it easy always to distinguish them from each other, with the exception, however, of the innermost layer, which can generally be more easily traced than any of the rest, on account of its peculiar yellow colour.

Upon the surface of the most salient portion of the projecting follicle (*fig.* 380. *a*) the peritoneum, as already stated, may be wanting; the tunica albuginea also beneath has become greatly attenuated, and is sometimes found completely eroded, whilst internally the yellow coat of the follicle is also observed to be thinnest about this spot. Every preparation, therefore, is made for the laceration of the follicle at a given point, the seat of which can also be further determined by the observation that in this place the conjoined membranes, previously highly vascular, have become more transparent, whilst their vessels, having become atrophied by compression, now carry little or no blood.

A very slight force is now sufficient to produce the rupture of the follicle in this precise spot, and such a force is supplied by the gradual accumulation of fluid, whether albuminous or sanguineous, or both, within the cavity.

It is believed by Coste that when the ovisacs have reached this point, which is the full term of their growth, they may remain stationary until a state of excitement arises, produced partly by the maturity of the ovum, and partly by the approach of the sexes, and that it is under the influence of such an excitement that the rupture of the follicle most commonly takes place. What probability there is for such a supposition will be hereafter more fully considered. Whether influenced by any external stimulus, or whether occurring spontaneously, and from causes existing within the follicle, the increase of its fluid contents becomes at length so great that the cavity is distended beyond measure, and its walls can no longer resist the pressure, but give way at the thinnest and most projecting part. But it is probable that another power comes also into operation to aid this process. The wavy outline which has been already noticed (*fig.* 381. *c*) as presented in a slight degree by the still unbroken ovisac, together with a certain amount of thickening of this coat, indicates a growth of this more rapid in proportion than that of the outer layer or tunic of the ovisac. This, therefore, will in some degree add to the pressure, because the outer layer of the follicle not being distensible beyond a certain limit, any increase of the contents, whether fluid or solid, will alike contribute to augment the force which is brought to bear upon the weakest point of the walls.

As soon as the rupture has taken place, and the opening in the coats of the follicle and in the corresponding portion of the ovarian coverings is sufficiently large to admit of the passage of the ovum, the latter escapes, together with portions of the membrana granulosa.

On one occasion Pouchet was so fortunate as to meet with an opportunity of observing the ovum as it was in the act of escaping from the ovisac, and was lying between the margins of the lacerated opening.

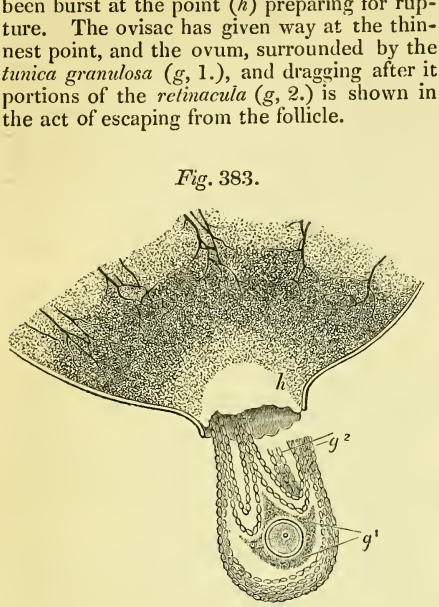
Of the five coats which together compose the ovarian and follicular walls, four only, it will be observed, can offer any obstacle to the escape of the ovum; because the membrana granulosa, which is the innermost of all, contains rather than covers the ovum, whose escape cannot be impeded, but will be rather assisted by that membrane. Barry explains the mode in which this probably occurs as follows: — The ovum, imbedded in the cumulus and granular disc which form the centre of the membrana granulosa, at the moment when the laceration occurs, experiences the *vis à tergo* occasioned by the pressure forward of the fluid, endeavouring to escape from within the follicle. This pressure is increased by the thickening of the inner wall of the follicle, amounting in some instances to an exuberant growth, which will act upon the ovum through the medium of this fluid. The obstacle to the escape of the ovum which had up to this moment existed, being removed by the laceration and absorption of the ovarian and follicular walls, that portion of the membrana granulosa which lies immediately behind the lacerated coats, where the ovum is imbedded, presents a surface for the operation of the *vis à tergo* more or less considerable, according to the extent of the rupture.

And now the elasticity of the coats of the follicle, together with some pressure from the weight of the parts surrounding its base, come in aid of this force, and complete the expulsion of the ovum, which escapes together with a portion of the membrana granulosa, and passes into the infundibular end of the oviduct.

Fig. 383. shows the mode in which this pro-

cess occurs in the rabbit. Here is represented a portion of a ripe Graafian vesicle, which was upon the point of discharging an ovum. The follicle, after being dissected out of the ovary, has been subjected to slight lateral pressure in the compressorium, by which the follicle has been burst at the point (*h*) preparing for rupture. The ovisac has given way at the thinnest point, and the ovum, surrounded by the *tunica granulosa* (*g*, 1.), and dragging after it portions of the *retinacula* (*g*, 2.) is shown in the act of escaping from the follicle.

Fig. 383.

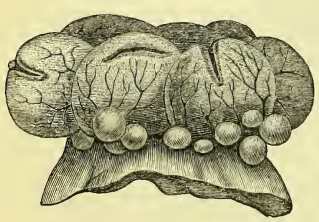


Ovum of the rabbit in the act of escaping from a ruptured Graafian follicle. (*After Barry.*)

The ovum is surrounded by the tunica granulosa, g^1, and draws after it the portion of membrana granulosa termed the retinacula, g^2; at *h*, where the rupture has taken place, the coats of the follicle are attenuated, and towards this spot numerous vessels converge.

The form and size of the aperture by which the ovum escapes varies considerably. In the rabbit it generally appears in the form of a small round aperture in the midst of a bright red spot, which is margined by a little network of capillaries filled with blood (*fig.* 383. *h*). In the sow the aperture is generally oblong

Fig. 384.



Portion of ovary of the sow. Three of the largest follicles have burst simultaneously, and exhibit wide lacerations. Others, less forward, remain unruptured. At the base are several unripe follicles. (*After Pouchet.*)

(*fig.* 384.), and from $1\frac{1}{2}$ to $7'''$ in length; the laceration in the latter sometimes extending through the entire diameter of the follicle, and permitting the escape of the whole of its contents, together with the ovum.

The laceration is not necessarily limited to a single follicle. In multiparient animals (*fig.* 384.) all or a greater portion of those follicles which have attained their full development undergo laceration, and emit their ova about the same time. In some of these, however, the effort may prove abortive, and the follicles may remain stationary until another impulse to rupture occurs, and the ova may then be discharged, or may, on the other hand, perish or be absorbed.

In Man, although generally uniparient, two or more follicles may likewise become matured about the same time, and their bursting may take place simultaneously. Of this fact I possess the proof in a case (*fig.* 409. page 605.) in which I found in one ovary three distinct apertures leading to as many developed ovisacs, all of which presented the characters just described as indicating the recently ruptured follicle. In this case the woman died during menstruation.

Such an observation is interesting, as showing in what way multiple pregnancies may occur in the human subject, for the whole of the ova discharged under such circumstances may be impregnated by a single coitus; although it is also possible that the bursting of one follicle only may suffice for the production of twins, since two ova have been several times observed in a single follicle in the Mammalia, and this may also possibly be sometimes the case in Man.

Before proceeding to the consideration of the remaining changes which the Graafian follicle undergoes, it may be useful here to make one or two observations on the conditions already described. Up to the moment of rupture, the progress of the follicle is one of regular advancement from an embryonic condition to a state of full maturity. The object of this progressive advancement is the protection, maturation, and final expulsion of the ovum, in such a manner that this last step may occur at a time when the ovum will be placed in circumstances the most favourable for impregnation.

In order to accomplish this, the ultimate purpose of all these progressive changes, the ovisacs which had been previously set more or less deeply in the ovarian parenchyma reach, one by one, the surface of this organ, and there, swelling rapidly from the increased secretion into their interior, and the growth of their walls, as we have seen, burst and emit their contents. The whole of these changes occur in regular sequence, and affect one or more follicles in succession. These follicles, lying buried in countless numbers in the substance of the ovary, supply, as it were, the pabulum for the morphological changes here described; a certain number only being called into full maturity, whilst the greater portion of those which were originally formed

in infancy, or which may continue to form during life, undoubtedly perish. No sexual influence is needful to the production of any of these changes. The whole occur spontaneously, whatever may be the condition of the female.

How far the influence of the male may assist in hurrying on to maturity any of these processes is a question which will be considered hereafter, when the proofs of the statements now made as to the independence of these processes will also be investigated. But it is sufficient here to refer to the fact of the spontaneity of these occurrences, in order to place under one category all the changes which the ovary suffers, up to a certain point, independently of any sexual influence.

Two circumstances here also may be more especially noticed: the one is, that the yellow colour which the proper ovisac or inner coat of the follicle exhibits towards the term of its ripening is distinctly recognisable for some time anterior to the occurrence of the rupture. It occurs in all follicles at this stage alike, both in Man and animals, and under all circumstances, whether coitus be permitted or not; but even when coitus is permitted, it is found at a period long anterior to that at which the act of coition could by any possibility be influential in its production.

The other circumstance which it may be important here to notice is, that the yellow structure is no new nor superadded part, but is the ovisac itself, altered by the gradual deposit in its texture of a yellow oil, which at length accumulates to such a degree as to convert this previously translucent wall of the follicle into an opaque yellow membrane or coat. But neither in any of these stages, nor in any subsequent ones, is there interposed either between the walls of the follicle or between these latter and the surrounding ovarian stroma, any new substance or body of any kind. The yellow colour is confined to the inner coat of the follicle, nor have I ever seen it in any one instance penetrating to the outer coat or covering of the ovisac. There is only one new coat formed, which will be hereafter described; and that coat, often of considerable thickness, is a part entirely superadded, which, after a certain stage in the metamorphosis of the follicle, is applied in the inner side again of the yellow coat, to which it forms a lining. This, although a new formation, is also, as will be presently shown, constructed out of materials existing in the follicle before its rupture.

The final purpose of the Graafian follicle being now accomplished, it may seem a matter of comparatively little interest or importance, in a physiological point of view, to trace its ultimate conditions; for the changes which this structure next undergoes have for their object solely its obliteration. But the process of obliteration or retrogression does not, like the process of development, take place under all circumstances alike. Here the influence of impregnation is exhibited in a degree so remarkable as to have given rise to a general belief that the changes experienced by the follicle, when impregnation has accompanied or followed its rupture, are essentially different in their nature and character from those which ensue when impregnation has not taken place; whereas these differences, it will be shown, are differences chiefly of degree; and yet they are so considerable as to have called forth almost as great a share of attention as has been given, perhaps, to any structure in the human body.

But great as is the interest attached to this structure on account of the evidence which it may afford of the previous occurrence or non-occurrence of impregnation, yet, so various are the views and statements of those who have specially directed their attention to the subject, that neither among physiologists, pathologists, nor medical jurists, can it be said that there is at present any concord of opinion or common ground of understanding.

Admitting, however, for the present that there is a marked difference observable in the changes which the Graafian follicle undergoes, according as impregnation has or has not accompanied or followed the escape of the ovum, we thereby obtain a starting-point, or rather a point of divergence, from which we may follow out these changes in two different series: the one series will include the alterations in the follicle which ensue when impregnation fails, or does not occur; the other, those which it experiences in consequence of impregnation having taken place.

Fourth Stage. Period of Decline and Obliteration of the Graafian Follicles.

A. *Without Impregnation.*—This constitutes the first degree of the descending scale in the history of development of the follicle. Immediately after the escape of the ovum, the inherent contractility of the tunica albuginea of the ovary occasions a diminution in the prominence of the lacerated vesicle. The margins of the opening become approximated in consequence of the collapsing of the walls, and from the edges of the laceration there occurs a slight fibrinous exudation which causes them to become agglutinated. If the aperture has been of considerable size, and no clot remains in the cavity to keep its walls from collapsing, the process of obliteration may proceed rapidly; but if a clot remains, and especially if it is of considerable size, it will serve to support the walls, and prevent them from quickly shrinking.

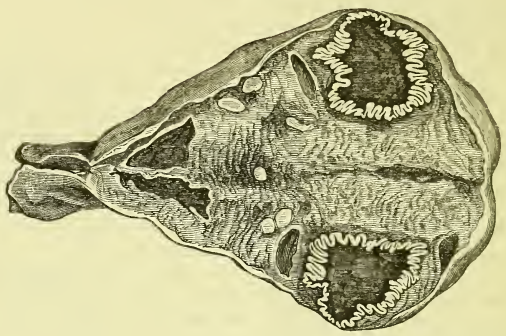
These different conditions will for a time affect the new disposition which the inner membrane of the follicle takes soon after the rupture is complete. In proportion as the cavity is empty, the elasticity of the outer fibrous coat will, by its retraction, occasion a diminution of the cavity; but the inner coat, having already increased during the growth of the follicle in a greater degree than its outer covering, will now, in this collapsed and nearly empty condition of the sac, suffer the same change that would result from enclosing a large bladder within a smaller one.

The inner coat becomes folded, and forms convolutions, which increase and become deeper in proportion as the retractility of the external tunic increases.

These convolutions in the inner and now yellow coat of the follicle are so distinct and striking (*fig.* 385.) as to have suggested those comparisons with the cerebral convolutions which so many authors have employed in describing this change; for the colour, as well as the nature and arrangement of the foldings, constituting ridges and sulci, produce an exact miniature resemblance to the surface of the brain.

If the blood-clot, which is generally found contained within the ruptured ovisac, be of considerable size, its surface will frequently exhibit little furrows, more or less deep, cor-

Fig. 385.



Section of the ovary of a woman who was poisoned by opium. A large Graafian follicle, which had recently burst and discharged its contents, is laid open. The part of the ovary surrounding the aperture was loaded with vessels full of blood. The convolutions of the collapsing follicle are very distinct. The follicle is empty. (*Ad Nat.*)

responding with the convolutions of the ovisac, by contact with which they have been impressed. This clot becomes adherent to the walls of the ovisac; assumes by degrees a pale rose hue; and gradually diminishing by absorption and contraction, it constitutes a centre, towards which the rays of the convolutions from all sides are directed.

But if there be no considerable clot in the centre of the follicle, then its closure proceeds more rapidly. The angles of the convolutions approach each other more nearly, but there still remains a space in the centre which may be empty, or contains only the debris of old coagula.

Lastly, if the cavity is empty, the retractility of its outer coat soon effects its closure. The angles of the convolutions, now compressed one against the other, come into contact across the cavity, and end by adhering together, and so the cavity is obliterated.

If, during the progress of these changes within the follicle, the external surface of the ovary be examined about the seat of rupture, it will be found that the parts in the immediate neighbourhood of the laceration become paler, that the blood gradually deserts the vessels, which were before highly congested, in this situation; and that, as cicatrisation advances, the zone becomes less and less distinct, disappearing, finally, about the time when the last traces of the laceration are effaced.

These changes in the ovarian follicle after rupture exhibit certain differences among the Mammalia, in some of whom, for example, there may be seen to project from the aperture a fleshy mass, sometimes occasioned by the presence of a coagulum, but more constantly by an exuberant growth of the lining membrane of the follicle, which for some time protrudes through the orifice, and may often, at this stage, be drawn out entire by the forceps, without difficulty. Its colour is not alike in all the Mammalia. In the sow, it resembles the liver of a calf; in the cow and sheep, it is of a brick-red.

In Man, the follicle has generally shrunk to very small dimensions by the time that one or more of the next series, which is preparing for development, have reached and protruded from the surface. The cavity by this time is nearly effaced. The chrome-yellow colour of the walls has also disappeared, and the ovisac has gradually become white. Its appearance upon section at this time is very striking and characteristic. In the centre (*fig.* 372. *h*) is still perceptible a small space, which might contain the head of a pin. It is surrounded by a white irregular circle, from which proceed outwardly about a dozen little rays. The circle is formed by the united inner angles of the follicular convolutions. The rays consist each of a double layer of the folded membrane. The apices of the rays are the original outer angles of the serpentine folds or convolutions of the ovisac. The outer coat of the Graafian follicle can now no longer be seen. At this time, the remnant of the shrunken vesicle measures about $1\frac{1}{2}'''$ diam.

Finally, whilst the foregoing changes are proceeding internally, a corresponding alteration takes place at the surface of the ovary.

The closure of the aperture, by cohesion of its opposite sides, occasions a drawing together of the surrounding parts, and the accompanying collapse of the follicles causes the part of the ovarian surface in this situation to sink inwards. The depression thus caused is increased by the continued shrivelling of the follicle, and by its retiring inwards towards the centre of the ovary. This latter change is occasioned not so much by any activity on the part of the now empty follicle as by the approach of new and rising ones to the surface, by which the empty and useless ovisacs are now pressed aside.

By these successive retirings of the follicles after bursting, and by the cicatrisation of their apertures, the ovarian surface becomes gradually indented in all directions so as to exhibit those pits and furrows which are always seen upon the ovary in advanced life (*fig.* 390.); and these, occurring in women under every circumstance alike, afford one of the most convincing proofs that this discharge of ova from the ovary may and does occur independently of sexual congress.

Finally, the stellate remains of the follicle continue to decrease, and become gradually buried in the ovarian stroma, until they are entirely obliterated, thus giving place to other vesicles which pass through the same stages of growth and decadence.

B. *After Impregnation.*—Very different is the progress of the Graafian follicle after impregnation has taken place. Here, although the changes which occur have no other intelligible purpose than that of the final obliteration of the follicles, yet the process takes place much more slowly than it does when the ovipont has not been followed by conception. In this latter case, the metamorphosis of the follicle into the small yellow stellate organ takes place usually within a month from the time of rupture, and its subsequent reduction to the little white cicatrix previous to its total disappearance is completed in about the like period. But the follicle, which has discharged an ovum that has been afterwards impregnated, is not obliterated in a shorter time usually than 13—14 months. During that time it appears to undergo a great and remarkable development. But a close examination shows that this is not true development, in the ordinary sense of the word. It is not a forward movement, progressing towards any new purpose or end, but is only the same process of obliteration, conducted upon a larger scale, and with a greater abundance of materials than in the case of the ordinary follicles when impregnation has not occurred.

Apparently the chief difficulty which has stood in the way of a clear comprehension of this has arisen from a want of sufficient consideration of those altered circumstances in which the generative organs are placed after conception; for, from the moment that impregnation has occurred, all parts of the generative apparatus are brought under the influence of a common stimulus, and all manifest in a greater or lesser degree some progressive change. This is more particularly observable in the internal organs, and especially in the uterus, which very soon receives a larger supply of blood. But the blood-vessels supplying the uterus inosculate so freely with those of the ovary, that the two organs may be practically regarded as deriving their blood from one common source. Each may be injected from the vessels of the other, and though only one set be selected, both are alike filled.

Hence it may be assumed that, although there is no direct continuity of texture between the ovary and the uterus, yet, under the influence of a common supply of formative material, as well as a common innervation, there may be established such a consent of action as will account, in some degree at least, for the differences which we are now about to consider; for when, after the discharge of the ovum from the ovary, impregnation fails, or has not been attempted, the internal organs, previously highly vascular, subside into a passive or quiescent state until the period of the next ovipont approaches, when the uterus again exhibits the same condition of turgescence. But if impregnation has taken place, then the turgescence of the uterus, far from subsiding, only increases, and certain of its textures now become rapidly evolved. The reproductive act, however, does not commence in the uterus. The ovary is the seat of the first changes, and the uterus is only placed in a condition of readiness, on each occasion of the ovipont, to carry on and complete the process which has been commenced in the former organ. The absence of impregnation, on the one hand, is the cause of the failure of the further stages of the process; the occurrence of impregnation, on the other hand, establishes these stages; consequently the ovisac which is about to discharge, or one which has just discharged an ovum, and the uterus which is about to receive or which has just received that ovum, are both placed under similar conditions. Whatever influences the one in the direction of development, affects the other also, to a certain degree, in the same direction. Whatever, on the other hand, determines the retrogression of the one, determines, in like manner, the receding of the other. If the ovum has become impregnated, the follicle which was the first birthplace of that particular ovum, and the uterus which subsequently receives and protects it, continue alike to suffer change. But if the ovum perishes, the recipient organ feels no stimulus, is not excited to further preparation, subsides into its former state of quiescence, and its producing capsule likewise shrinks, and finally disappears. If the inquiry be prosecuted further in the hope of eliciting some more satisfactory explanation of this remarkable series of changes, the investigation will, in the present state of our knowledge, be found altogether to fail. The question, *Cui bono?* continues unanswered, but the fact remains, and the law appears to be invariable.

When conception has followed the discharge of an ovum from the ovarium, the follicle

which produced it closes in the same manner as when conception has not occurred, but it does not shrink rapidly, as in the latter case. On the contrary, the inner coat or original ovisac continues to increase in thickness, in consequence of a still larger deposit of yellow oil granules in its substance. The outer coat of the follicle or tunic of the ovisac suffers no change; but upon the interior of the ovisac, and therefore lining the cavity, is formed a membrane, the origin and nature of which will be presently considered; or else it may happen that the cavity becomes obliterated by the organisation of the clot by which it had been at first filled.

After conception it is probable that the actual diameter of the follicle does not at any time materially increase. So great, however, are the variations in its size in different subjects, that this point scarcely admits of being accurately determined. The Graafian follicle may, at the time of rupture, occupy $\frac{1}{4}$, $\frac{1}{3}$, or $\frac{1}{2}$ of the entire ovary. These at least are the dimensions which it is usually found to have, in different instances, during the first four months of pregnancy; but after this period the process of diminution begins to be perceptible. All the changes which are now observable in regard to form, solidity, and other particulars obvious to the unaided senses, and all the histological changes are to be looked for within the outer coat of the follicle. The latter appears to suffer no alteration, but simply to follow the movements of its contained parts, around which it remains loosely applied. The ovisac, however, or inner coat, rapidly increases in thickness, in consequence of a more considerable accumulation in its texture of the same yellow oil whose deposition had begun in it long before the follicle had ruptured, and when it was only approaching the surface of the ovary.

This thickening of the inner follicular coat is followed by a twofold result. The membrane, being confined by its outer tunic, now no longer distensible, as well as by the surrounding stroma into which the vesicle has now begun to sink, becomes more deeply plicated; and since it can no longer extend outwardly, it must of necessity encroach upon the cavity within. The latter thus becomes sensibly diminished, whilst the entire thickness of its boundary wall is in like proportion increased.

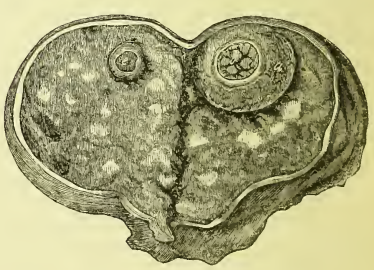
At the end of the first two months of gestation, the follicle possesses considerable solidity. The wavy and plicated condition of the yellow ovisac is now less distinct. The whole of this coat exhibits the appearance of a thick yellow layer, still occasionally traversed by numerous little blood-vessels, which run across it in straight lines from without inwards as far as its inner surface. The larger of these vessels probably do not actually pierce the yellow coat, but lie between the sulci, representing the original folds of the ovisac, and which, now pressed back to back without being yet obliterated, would still serve for the conveyance of blood-vessels to different parts of the tunic.

These changes continued to be in a certain sense progressive until the fourth month of gestation, about which time the Graafian follicle is usually considered to attain its highest state of development. But if the term development be admitted, it should be remembered that the only apparent purpose of these and other changes which ensue is still the obliteration of the structures in which they occur. The process of obliteration, however, has at this time not proceeded so far as to have caused the removal or even diminution of any of the original parts composing the follicle, whilst some new structures are superadded or produced by metamorphosis of the original materials.

The follicle at this period generally affords the best opportunity for observing the changes which result from impregnation. It may therefore be selected for a critical examination of the subject.

The external condition of the ovary in which such a follicle is contained serves at once to point out the precise seat which the structure occupies. Not only is the entire ovary larger than that of the opposite side, but it appears more swollen, and is perceptibly harder in one particular spot; over or near this spot a cicatrix may still be visible, and in its immediate neighbourhood are often found some serpentine vessels. If, now, a section be made of the ovary in this situation so as not to pass through the centre, but to include only a portion of the circumference of the follicle, the latter will present the condition represented in *fig.* 386. The follicle, in the form of a little globe, is seen to occupy about a fourth part of the ovary. Its solidity and spherical form cause it to project considerably above the surface of the section. In this way is exposed the outer coat by which the follicle is bounded. Upon this coat numerous blood-vessels, derived from the ovarian stroma, ramify. It is the tunic of the ovisac, the origi-

Fig. 386.



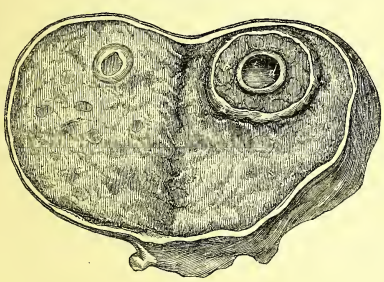
Section of the ovary of a woman who died at the end of the fourth month of utero-gestation. The Graafian follicle of the ovum which had been impregnated projects above the stroma. (*Ad Nat.*)

a, outer vascular coat (tunic of the ovisac); *b*, yellow inner coat (ovisac), from which a thin slice has been removed, not deep enough to lay open the cavity, but displaying the brain-like convolutions; *e*, portion of the follicle corresponding to *b*.

nal outer coat of the Graafian follicle, which in all the transformations of the latter suffers no change, until the time arrives when the whole body finally shrinks and disappears. The position and relations of this coat to surrounding parts leave no room for doubt as to its identity. Nothing bounds it externally but the stroma of the ovary. Nothing lines it internally but the yellow ovisac. Neither between its outer nor its inner surfaces, and the corresponding structures just named, is there at any time found any substance or medium interposed. This coat has undergone no material thickening, and its histological elements are simply those of the outer coat of the follicle, the same as before impregnation has occurred.

Proceeding inwards, the next coat is yellow; it has a nearly uniform thickness of $1\frac{1}{2}'''$. In its substance may still be seen traces of the original foldings or convolutions. These are more easily shown upon the surface of the first section (*fig.* 386.), but are less obvious in one carried deeper so as to include the centre of the follicle, where the

Fig. 387.

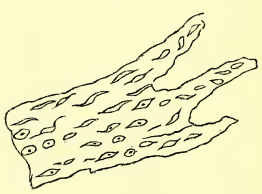


Deeper section of the same Graafian follicle as in fig. 386. *The cavity, which contains a remarkably clear fluid, is exposed.* (*Ad Nat.*)

a, outer vascular coat (tunic of the ovisac); *b*, inner yellow coat, or corpus luteum (ovisac); *c*, white membrane lining the cavity (a new formation); *d*, cavity empty.

coat shows greater solidity (*fig.* 387.). Up to this time, however, and sometimes later, the vessels still traversing this coat in the lines of its former convolutions may be traced in many specimens, and the capillaries may still be filled by a successful injection to such an extent as to render the whole mass crimson.* Examined by the microscope, the following results are obtained:—The yellow coat, $1\text{-}1\frac{1}{2}'''$ thick, is soft, swells in water, and is easily torn into fragments which nevertheless hang together, being connected by a tough flexible medium. During this process numerous oil droplets escape, and form, with the drop of water in which the preparation is placed, a highly refractive fluid. This fluid, when examined, is seen to contain numerous particles of inappreciable size endowed with molecular motion, minute granules, and oil globules, which are at first also very minute, but soon collect and coalesce into larger drops that float to the surface of the fluid. The substance of the preparation also is everywhere pervaded by the oil drops which obscure its structure, and prevent further examination in this state. The preparation, having been treated next by ether, and subsequently washed in alcohol and replaced in water, it is found that the oil has entirely disappeared. The principal portion of the remaining substance has the appearance of a granular membrane, but in many places slightly wavy lines of connective tissue are perceptible. From the margins project in many places flattened bands composed of 8-10 filaments of common connective tissue, united by membrane, and having attached to them numerous granules. Separate fibres also appear at the margin of the preparation, but only from forcible detachment. Treated further by acetic acid, the oil globules, as well as the fibres, have totally disappeared. The course of the latter is now only indicated by numerous lines of round, oval, or elongated nuclei (*fig.* 388.), which are everywhere abundantly seen attached to a fine, structureless, transparent membrane. The outlines of the

Fig. 388.



× 350.

nuclei are very sharp and distinct, and within them are contained one or two nucleoli. This coat is traversed by numerous blood-vessels and capillaries, and to their coats in all probability many of these nuclei belong.

The yellow coat is bounded internally by a third tunic which is white, having precisely the milk-white colour, and very nearly the consistence, of articular cartilage. It is of variable thickness, but often $\frac{2}{5}'''$ or more in diameter. It is very tough and coherent in texture, and is with difficulty split by needles, breaking into irregular fragments. These, examined by the microscope, are seen to be composed of tough fibres of connective tissue, whose arrangement in wavy lines may be perceived through the mass, but which are so closely connected together by a semitransparent membranous medium as to be inseparable into distinct fibrillæ, except at the margins of the fragments, where they are tolerably distinct; where also the connecting medium may be seen in the form of a structureless membrane. Minute granules are everywhere seen scattered throughout the mass, and adherent to the detached fibrillæ. Treated by acetic acid, the fibres become transparent and pale, their outlines being hardly distinguishable. Oval nuclei, rather scanty, lie in the direction of the fibres. The whole sub-

* Montgomery, Signs of Pregnancy, p. 227.

stance has the appearance of a tissue which is in a low state of vitality.

It is probable that the presence of this coat within the follicle has been the cause of most of the differences of opinion which have existed regarding both the seat and the nature of the yellow portion of the follicle of pregnancy. It seems to have been assumed, without further examination by many who have written upon this subject, that the coat last described is one of the coats originally composing the Graafian follicle; whereas it is formed by the metamorphosis of the blood-clot, already described as occupying the centre of the follicle before even the ovum escapes. I have seen very distinctly the fibrillation of this clot soon after the follicle has closed. It is then found to be gradually becoming pale, the red particles disappear by degrees, the clot adheres firmly to the inner surface of the ovisac, and the mass is converted into the low form of tissue just described, which may either take the condition of a membrane lining the cavity and leaving a central space filled by transparent fluid, or the whole may be converted into a solid body. Either of these forms may be observed, and the knowledge that each may occur disposes of the speculative question as to the time when the cavity of the follicle is obliterated.

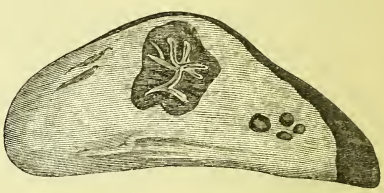
On the other hand, the yellow coat which has been often described by authors as altogether a new formation, deposited either between or external to both of the follicular coats, can be most easily traced through all its phases, beginning in the ascending vesicle, as the original ovisac; its structure filled with nucleated cells, which gradually become charged with oil droplets until the whole tissue assumes the peculiar yellow which is so distinct about the time of bursting of the follicle. And this colour it never loses until the time of its complete obliteration approaches; but through all the subsequent changes of the follicle the same anatomical structure and the same relative position of parts is preserved.

In the original preparation from which *fig.* 387. was taken, nothing served to distinguish the several coats better than their colour. The outer coat or theca folliculi was red; the second coat, or ovisac itself, chrome yellow; the now internal and newly formed coat was milk-white.

It remains to describe the cavity in the interior of the follicle, which, though sometimes obliterated, is more frequently found still existing at the fourth month of utero-gestation. In the specimen represented in *fig.* 387. the cavity measured 3‴ in diameter and contained a clear gelatinous fluid. In other cases a cavity at this time no longer exists, but the centre of the ovisac is occupied by a tough white substance, whose origin has just been explained.

It will not be requisite to follow out minutely the remaining changes which the Graafian follicle undergoes. After the fourth or fifth month of pregnancy a certain diminution in size begins to be perceptible. The walls of the cavity approach nearer to each other, and the white lining becomes thinner, and begins to be folded into plaits which, radiating outwardly, are seen intermingling with the yellow colour of the proper ovisac (*fig.* 389.). The outer boundary of the follicle also now presents an irregular and somewhat angular and occasionally an oval outline. These changes proceed with much variation in different subjects; but usually at the time of delivery the ovisac, though still yellow, has lost much of its brightness, and the cavity, if it had existed, is replaced by a solid white stellate cicatrix (*fig.* 389.) caused by the folding of the white lining

Fig. 389.



Graafian follicle two days after mature delivery. The white lining of the cavity (c, fig. 387.) is here folded into a stellate figure. It is surrounded by the darker yellow ovisac (corpus luteum), whose outline is become angular. (After Montgomery.)

membrane which bounded the ovisac on its inner surface. That the yellow coat is still vascular at this time is proved by the fact mentioned in the preceding page.

In proportion as the entire generative organs subside into a quiescent state, so the remaining changes in the ovary take place more rapidly. The yellow colour of the ovisac passes into a paler hue, and at last into white. The radiating cicatrix may still be traced for some time longer, until, at the end of four or five months after delivery, every appearance of this structure has ceased to be discernible.

Certain physiological questions intimately connected with the foregoing history of the development and involution of the ovarian follicle may now be briefly considered. And first it may be asked—

Does the discharge of ova from the ovary take place independently of sexual intercourse, or of any kind of influence from the male?

This question has long ceased to be agitated with reference to animals lower in the scale than the Mammalia. It need, therefore, now only be considered in its relation to the latter, including Man. And since many have recently undertaken to prove that Man and the Mammalia constitute no exception to the general rule that in all classes of the animal kingdom which produce and emit ova the act of emission of ova is independent of the male, so, whatever form the inquiry may now take, it would naturally have for its chief object the determination of the value of the evidence upon which such an assertion has been based.

Now, the facility with which the process of ovulation may be observed in animals justifies

the expectation that in such a case the amount of objective proof, collected by those who have undertaken to establish a law of spontaneous ovulation in Mammalia, would be sufficient to prove that law beyond the possibility of question. But when we turn to the principal writers who have devoted their attention to this point, with the view of collecting and critically examining such evidence, it must be confessed that the result is productive of a certain feeling of disappointment at the form in which the facts have been recorded, and the circumstances under which the observations and experiments have generally been made.

This is more particularly felt when, after examination of the evidence adduced, an unhesitating acceptance of the law, as one of universal application, is demanded. Before, however, the question of universality is considered, it will suffice, for the purpose of proving the possibility of a spontaneous ovipont, to give one or two examples in which all the conditions necessary to establish this fact were observed, viz., absence of coitus, rupture of the ovarian follicle, and the presence of the unimpregnated ovum in the oviduct.

The following case is related by Bischoff.* A lamb which had never received the male, and which had exhibited signs of "heat" about an hour previously, was shut up alone. On the following morning the male was admitted (for the purpose of testing the heat). He several times showed a desire for the coitus, but was prevented. The animal was killed the same afternoon, when it was found that a Graafian vesicle in the right ovary had burst. The spot did not project from the surface of the ovary, but attracted attention by the circle of red vessels surrounding the small opening which constitutes a familiar appearance in dogs and rabbits after bursting of a follicle. The diameter of this opening was about $\frac{2}{5}'''$. As a matter of precaution, search was made for spermatozoa, in order to obtain the negative certainty that no coition had taken place, but none were found. The infundibulum contained a thread of mucus intermixed with granules resembling those of the membrana granulosa. The Fallopian tube was next carefully examined, and at a distance of $5'''$ from its entrance was found an ovum still surrounded by the cells of the granular disc, and possessing all the characters of the unimpregnated ovarian ovum.

But since in this instance the presence of the male was permitted, though coitus was prevented, as was also the case in one half of the instances recorded by Bischoff in his celebrated Treatise from which this example is quoted, it may be well to notice another observation taken from Raciborski †, in which this possible objection was removed.

A bitch which had never been covered, and was just commencing to be in heat, was kept shut up for eight days, apart from other dogs. It was then killed. Only one ovary was examined, the other having been laid aside and forgotten. Three large follicles of a lively red occupied the entire surface of the ovary. One of these follicles was already shrunk, and presented at its summit a distinct fissure. In each cornu of the uterus, an ovum, the size of a poppy-seed, was found, surrounded by bloody mucus, — the one at a distance of about $2\frac{1}{4}$ inches, and the other at $\frac{3}{4}$ of an inch from the extremities of the tubes. Doubtless, if the other ovary had been examined, at least one follicle would have been found to have opened there also.

In order to show that the same process of discharge of the ovum, independent of sexual congress, may take place in the human subject, a case, recorded by Dr. Letheby, may be here quoted*:—"The body of a lunatic, aged 23, who had died in St. Luke's Hospital, was examined. She had been a patient in that institution for eleven months, under circumstances which deprived her of the opportunity of associating with a male for a long period before her death. It was ascertained that the girl had quitted life during a menstrual period; the cavity of the uterus, and the Fallopian tubes, contained a red, jelly-like secretion. On the outer and lower part of the right ovary was a dark livid spot, in the centre of which was a hole. On making a section of the ovary so as to divide it through the spot and an adjacent cicatrix, it was perceived that the hole led into a cavity which was surrounded by a dark-red tissue, and that the cicatrix communicated with a very perfectly-formed *corpus luteum*, having a central cavity containing a dark-red clot. In the right Fallopian tube was discovered a little globular body of the size of a pin's head. This was seen, under the microscope, to consist, in its outer surface, of a mass of nucleated cells. At one end of this mass was a transparent ring, enclosing a rather opaque granular mass, in which there was an eccentric spot." The author had no doubt that this was the ovule consisting of the zona pellucida, yolk, and germinal vesicle. In another case related at the same time, and where the hymen was perfect, similar results were obtained.

The possibility of a spontaneous ovipont having been established by these and like instances which might be quoted, it becomes important next to determine how far the law just enunciated is universal in its application; we may therefore inquire, —

Does the discharge of ova from the ovary always take place spontaneously, and independent of sexual intercourse?

It is in endeavouring to determine this question, so far as the attempt has been made to base this law upon observations and experiments on animals, that the difficulty to which I have just adverted is experienced; for, whilst there is no lack of argument upon the subject, it must be confessed that the number of well-recorded instances proving a spon-

* Beweis, p. 24. See next page.
† De la Puberté, p. 376.

* Phil. Trans, 1852, pt. i. p. 5.

taneous ovipont in mammals is exceedingly small.

It will suffice for illustration to observe the manner in which this question has been handled in the celebrated works of Bischoff*, Raciborski†, Coste‡, and Pouchet.§ The first only of these authors has given in detail the observations and experiments upon which he has endeavoured to found a law of spontaneous ovulation in the Mammalia. In several of these the coitus was permitted ; and although it is rendered highly probable, from the circumstances narrated, that in some this had no effect in producing the discharge of ova, yet the introduction in any form of the only condition that could vitiate the experiments detracts certainly from their value. In five, however, of Bischoff's experiments it was known that coitus had not occurred, and in three of these ova were found discharged, accompanied by the usual appearances in the ovaries indicative of the recent rupture of the follicle.‖ In a fourth case, the state of the ovaries left no doubt that the ova, which could not be found, had escaped; while a fifth case was examined before the ova had escaped. To these Bischoff adds an example of the ovipont in an animal, in which it was only probable that no coitus had occurred.

The work of Raciborski contains a single example, which has also just been quoted.

The works of Coste and Pouchet contain no examples of a spontaneous ovipont in animals, but the observations of each of these authors are given in the form of results. Each work contains a minute description of the process of ovulation, drawn apparently from separate observations ; but these descriptions are not accompanied by any detailed examples, nor any statement of the means used to render these observations proofs of an ovipont, independent of coitus.

But all these authors agree in stating that ovulation occurs independently of sexual union, whilst they differ as to the degree of strictness with which the universality of this law is enforced. Pouchet demands that the law should be received without any exception, and observes with surprise the "unaccountable vacillations" of those among his predecessors who yield to it only a partial assent.

But in the absence of any extensive series of well-recorded observations, whose numerical force shall be such as to compel a universal acceptance of the law, it is not surprising that some who regard it as having been too hastily framed, and as too rigid in its exclusiveness, should withhold their full assent to it. For let it be conceded that the ova, when they have attained their complete development, escape naturally from the ovary, the rupture of the follicle not necessarily requiring the intervention of the male, should it therefore be inferred that the latter is completely inoperative when exercised on opportune occasions ?

In this form the question is put by Coste, who maintains that although the coitus may not be the essential cause of the rupture of the follicle, yet it undoubtedly has the power to precipitate that event, and even to prevent its failure. He further considers that there is this difference between the fecundated female and one in whom impregnation does not take place ; that in the former the rupture of the follicle is prompt, whilst in the latter it is tardy, or even in certain cases fails to occur.

In order to support this view, Coste cites two observations upon the rabbit. In the first of these, the animal was in heat, and manifested great ardour for the male, but coitus was not permitted. It was kept for forty-eight hours, and then killed. The genital organs were highly congested. Six follicles in one ovary, and two in the other, were apparently ready to burst, but no rupture had yet taken place. In the second experiment, the animal remained in heat for three days ; on the fourth day the heat ceased, and on the fifth it was killed. The organs were in the same condition as in the last case, but no follicles had burst. Coste attributes the absence of rupture in these cases to the prevention of the coitus at a time when, if permitted, it would in his view have determined that event.

In whatever light these observations may be viewed, they are important as showing that an animal may sometimes advance far in the period of heat, and even pass through it without any ova escaping from the ovary ; but it would require a very much greater number of parallel observations to prove by such negative results the effects of the sexual congress in determining the act of the ovipont. And it is matter for regret that this point has not been more clearly determined ; for whilst no satisfactory results can be looked for from any observations upon this part of the subject in Man, this is eminently a question capable of being determined by experiments on animals. All the earlier observers who directed their attention to the condition of the ovaries in relation to reproduction bear unconscious testimony to the fact that the time at which the ova quit the ovaries bears no strict relation to the act of coition. Barry states that, taking the coitus as the starting-point of his reckoning, he was obliged to sacrifice a score of rabbits before he succeeded in meeting with one instance of the ovum at a particular time after its escape, and he had almost given up the attempt in despair.

If means be used to prevent the contact of the seminal fluid with the ova after their discharge from the ovary, or to prevent its arrival at the latter organ before rupture of the follicle, this does not affect the immediate condition of the follicle. The number of ruptured Graafian vesicles which have been found, after experiments made by placing ligatures upon

* Beweis der von der Begattung unabhängigen periodischen Reifung und Loslösung der Eier, &c. 1844.

† De la Puberté, et de la Ponte périodique. 1844.

‡ Histoire du Développement. 1847.

§ Théorie positive de l'Ovulation spontanée. 1847.

‖ One of these cases is given above.

the tubes before coitus was permitted, has usually amounted to the sum of the ova discharged. If one side of the uterus be tied, the ova found in that cornu will not have been impregnated, but those on the free side will be developed. The number of ruptured follicles in each ovary will agree with the number of ova found in the corresponding tubes; but no difference will be perceptible between those on the impregnated and those on the unimpregnated side of the uterus. The contact, therefore, of the seminal fluid with the ovary has nothing to do with the discharge of the ova, or with the formation of a "corpus luteum." The only question that can here have place is, whether the excitement of the coitus, or the contact of the seminal fluid with the inner surface of the vagina and uterus, has any influence in precipitating the discharge of ova from the ovary when they are ripe for impregnation. This, however, is, in the present state of our knowledge, an unsettled point. By all the earlier observers down to Barry, it was assumed that the coitus was the sole determining cause of the ovipont. By most physiologists since that time the coitus has been regarded as having nothing to do with the discharge of the ova, or only a limited power has been ceded to it, as in the view of Coste just detailed.

So far as numerical amount of recorded observation goes, it may be asserted that the spontaneity of the act of emission of ova, independent of sexual intercourse, has been more fully and satisfactorily proved in Man even than in animals. In the works and essays upon this subject, to which reference is given in the preceding page, a large amount of evidence will be found; but since some proofs of this fact have been already given, and since it is proposed again to return to the subject in considering the question of menstruation in its relation to ovulation, it will not be necessary to pursue the subject further here. (See page 666.)

In tracing the process of ovulation, it will have been observed that the ovarian follicle passes through a series of changes, so gradually progressive and of such a definite character, that the knowledge of these may be turned to great account in any investigations relating to the ovipont; for, next to the discovery of the ovum itself, whether in the ovary, Fallopian tube, or uterus, the condition of the capsule, from which it is about to be or has been already discharged, will afford the best evidence as to its probable locality and condition, even should the ovum not be found. Doubtless, one of the greatest impediments which has been encountered in investigations of this class arises from the extreme difficulty, and often the impossibility, of finding the ovum in many situations on account of its minute size. Hence, in the absence of this demonstrative evidence, which cannot always be obtained, any other, which, though only inferential, may be made available for a like purpose, is of great value. Wanting the ovum, therefore, the state of the ovicapsule may be made, in part at least, to supply the evidence which is deficient. Now it has been shown that, whatever affects the ovum, to determine its development or the converse affects in a like degree the follicle from which it had been discharged, not on account of any apparent sympathy between the ovum and the follicle which once contained it, but from the whole generative track being more or less brought under the power of one common stimulus, felt alike by all the parts that are employed for the nutrition and protection of the ovum. It will be desirable, therefore, now to determine what evidence the condition of the ovarian follicle affords, first, as to the previous escape of an ovum, and secondly as to the probability or certainty of that ovum having been impregnated or otherwise. But since it is desirable to fix the value of certain terms which are commonly employed to designate particular states of the follicle, it will be needful, first, to determine,

What is a corpus luteum?

This term, as Raciborski has observed, is indicative of the infancy of science. It belongs to a period when anatomists were in the habit of designating by the word body or *corpus* any part of the animal economy whose nature or relation with other parts they did not comprehend, adding to this some distinctive title drawn from the general appearance of the part. Hence the terms *corpus striatum*, *corpus callosum*, *corpus luteum*. It is an unfortunate circumstance that such a term was ever applied to the Graafian follicle, and the more so since it is often employed without any definite meaning.

The Graafian follicle in its progress towards full development, and previous to its rupture, has been described as becoming yellow. This fact has been long known. It is stated by Home, Baer, Valentin, Wagner, and Bischoff. The cause of the yellow colour has been fully explained. After impregnation this yellow colour becomes still more conspicuous on account of the greater thickness of the ovisac or inner coat of the follicle, which is the seat of the change producing this colour. From the greater distinctness, larger size, longer duration, and other peculiarities of the follicle after impregnation, an artificial distinction has been made between the follicle in this state, and all other forms of it, in which it exhibits the yellow colour. The former are arbitrarily called "true," and the latter "false" *corpora lutea*. But there is as little reason for the use of the last term, as there would be for denominating a child a false man; for that which is commonly designated the "true" *corpus luteum* is the follicle in its largest condition of growth, as it appears after impregnation; whilst in all other conditions, when it has not been stimulated to full growth by impregnation, and whether before or after rupture, it has been called a "false" *corpus luteum* so long as it possesses the yellow colour. This distinction, therefore, as far as regards the terms employed, is not only unscientific and arbitrary,

but is calculated to mislead by suggesting the idea that the so-called "true" *corpus luteum* is a totally different body from the "false," whereas these terms actually represent the same body, only in different stages of growth or decay. But practically it becomes a question how far it may be possible to determine, from the physical appearance of the follicle, whether impregnation has taken place. And this question is a very important one, especially in its obstetric and forensic bearings.

From the account already given of the several stages of growth and decay of the ovisac, it will have been seen that the yellow colour is common to all these alike, with the exception only of the earliest and the very latest stages. It alone, therefore, can afford no distinctive evidence upon the subject. But, in combination with other signs, the yellow colour, by its extent, may be made available to distinguish those cases in which impregnation has occurred; for when this is the case the ovisac, as stated, continues to increase in thickness; a greater abundance of yellow deposit takes place in its tissues; the follicle, instead of shrinking and disappearing in the course of one or two months, continues to be visible for fourteen or fifteen months. It acquires a new coat which lines its cavity, or else this cavity is entirely closed by a coagulum which becomes organised and solid; it presents the convoluted appearance which gives it a resemblance to the cerebral convolutions, and this convoluted condition gradually passes into one which is characterised by the presence of rays proceeding from a centre. Finally, the whole body constitutes a resisting and more or less solid mass, which can at once be detected by the touch, before the ovary is opened. The distinctions, therefore, are chiefly those of degree: the greater solidity; the greater thickness of the yellow walls; their more marked convolutions; the long persistent cavity, round or oval at first, and subsequently stellate; the milk-white membrane lining the cavity, when the latter exists, or the white dense mass occupying its place, resulting from the transformation of the clot. These last characteristics of the so-called true corpus luteum, viz., the cavity lined by the white membrane or the solid white centre, as well as the large central stellate cicatrix, may be regarded as absolute and not comparative distinctions, for they are not found in the follicle in process of involution when impregnation has not taken place.

With regard to scrofulous tubercles, which have been often enumerated among "false corpora lutea," it is probable that some of the conditions of the ovisac now described have been hastily set down to this score, without sufficient examination; for although scrofula may possibly affect the ovary, as it does the testis, yet a formation there of distinct scrofulous tubercles, unless they are abundant in other parts of the body, is, I am satisfied, a rare, if not an unknown, occurrence. No doubt, however, need at any time exist as to the nature of such bodies, since, if the bright yellow colour of the ovisac is not sufficiently marked, as in those cases where they have become pale, and more nearly approaching the buff colour of tuberculous matter in general, the microscope will at all times determine the question, for in respect of composition there is nothing in common between tuberculous matter and the ovisac in any of its natural stages of growth or decay.

Setting aside morbid states, nothing is ever seen in the perfectly healthy ovary except the stroma and ovisacs or Graafian vesicles in different stages of development or decline. These may be arranged in three series:

Ascending Series.

1. The simple undeveloped ovisac, before it has acquired an indusium from the stroma of the ovary, or from the walls of an already developed follicle, in which it may be formed. It requires at this time the microscope for its examination (*fig.* 373.).

2. The ovisac after it has acquired its outer capsule, by union with which it has become a Graafian follicle.

3. The Graafian follicle of the size of a hemp seed, or rather larger. It contains oil granules in the coats of the ovisac, but not yet in quantity sufficient to produce a yellow colour. In this state numerous follicles are seen in sections of every healthy ovary during middle life (*figs.* 370. and 372.).

4. The follicle when it is approaching the surface of the ovary. It is enlarging, and its inner coat or ovisac has now a yellow colour.

5. The ripe follicle which is about to rupture and discharge an ovum. It is always found at the surface of the ovary, projecting often to a distance of 3-4‴. It is covered by numerous veins, and in the centre of the most prominent part the coats of the follicle, as well as the ovarian coverings, are thinned and partly absorbed. Their thinness permits the contents of the follicle to be partly visible, and thus is produced a brownish red colour at this spot. The follicle contains blood or a bloody fluid, and sometimes a clot. The cavity is of considerable size, 4-6‴. The inner coat is of a bright yellow colour, and exhibits slightly wavy folds (*figs.* 380. and 381.).

6. The follicle which has already ruptured. An irregular lacerated opening extending ½-2‴ is perceptible in the centre of the attenuated part, through which the ovum, together with that portion of the membrana granulosa which lay beneath the seat of the rupture, has escaped, or is about to escape. The follicle is beginning to collapse. Its walls, no longer distended, become folded into numerous small plaits, producing, on section, the appearance resembling cerebral convolutions. The cavity is consequently diminished. It is empty, or contains a little bloody fluid or a clot (*fig.* 385.).

Descending Series. A. Not pregnant.

7. In the follicle which has recently burst, shrinking has commenced. The yellow ovisac is much plicated. The cavity contains a clot which is becoming pale, and exhibits under the

microscope distinct fibrillation, or the cavity is empty and much contracted.

8. The shrinking having rapidly progressed, the ovisac exhibits deep plications, and the rays are beginning to form, but the yellow colour is still distinct.

9. The cavity is nearly or entirely obliterated. The yellow colour is gone, but the rays remain, and the collapsed follicle now forms a white stellate body with a small central point (*fig.* 372. *h*).

10. The follicle itself is reduced to a mere point in which none of the foregoing characters can be traced.

Descending Series. B. After Impregnation.

11. The follicle has not materially diminished in size. The lacerated opening is closed. The yellow coat is much plicated, and the clot when present shows fibrillation, as in No. 7., or the cavity is empty.

12. The follicle has acquired greater firmness and solidity. The yellow ovisac is much increased in thickness. The folds are not so numerous, but are deeper, though not quite so distinct. Vessels contained between the folds appear to pervade the yellow coat. The white lining of the cavity is formed, and within it is a clear fluid, rather viscid, (*fig.* 387.), or the centre of the yellow ovisac is solid, and exhibits no cavity.

13. The central cavity is nearly or entirely obliterated. In the latter case a solid white body occupies its place, extending into the yellow mass in divergent rays. This arises from the plication of the white lining, by which process the cavity is closed. The colour of the principal mass is now a dirty yellow; it is somewhat reduced in size, and its outline is oval or irregular (*fig.* 389.).

14. The more prominent features observable in the last condition may still be faintly traced. In size the body measures 2-3‴. It is of a pale white, and is chiefly distinguishable from the surrounding stroma by the absence of vascularity in its tissues. Its solidity is gone.

To return, then, to the two questions which led to the foregoing considerations as necessary to their solution, viz.—

What evidence does the condition of the ovarian follicle afford, first, as to the previous escape of an ovum, and secondly, as to the probability or certainty that that ovum has been impregnated or otherwise?

It may be concluded that whenever the follicle presents the appearances exhibited in the first series down to and including No. 5., the ovum has not escaped; although it may not be detected, either on account of the difficulty of finding so small a body, or else because it may have perished by absorption or decomposition.

In the condition No. 6., an ovum has just escaped, or is in the act of escaping. None of these conditions of the follicle afford the slightest evidence of previous impregnation. They have all been repeatedly observed both in Man and animals where the coitus has never occurred.

Between No. 7. and No. 11. it may be difficult to draw a positive distinction. No conclusion regarding the question of previous fecundation, derived from the state of the follicle during the first fortnight after the escape of an ovum, would be absolutely safe; although the difference between the unimpregnated and the impregnated is such as to afford in every instance at least strong presumptive evidence, for the follicle shrinks rapidly in the former, while in the latter it undergoes little or no diminution in size.

But after this period there can be no question as to the prior occurrence of a fecundating coitus. Every follicle presenting the conditions described in Nos. 12, 13, and 14 has discharged an ovum, which has been afterwards impregnated. Every follicle in the states described in 8, 9, and 10 has discharged or has contained an ovum which has perished. But this proves only that fecundation has not occurred. It affords no evidence whatever that the coitus has not obtained.

Lastly, it may be observed that if, as is sometimes the case, the follicle fails to complete the process of rupture after the first steps of preparation have been made, the ovum may perish or be absorbed without being discharged, and the follicle will then shrink and become obliterated, as in the first series of changes. And it is further noticeable that although the number of Graafian follicles exhibiting the appearances indicative of the discharge or fecundation of ova, may generally be taken to represent the number of ova also actually discharged or fecundated, yet this will not always furnish a safe guide, because one follicle may contain two ova, or one or more ova may have escaped the influence of the coitus which had fecundated the rest. The number of ruptured or altered follicles therefore will in the first case be less, and in the second greater, than the number of ova or fœtuses found in the oviducts or uterus.

Development and Involution of the Ovary.

The Origin of the Ovary, and the Alterations which it undergoes at different Periods of Life.

The ovary takes its origin in a separate portion of blastema, quite independently of the Wolffian body, with which it is in close contact. It is not indeed until after the development of the Wolffian bodies has made considerable progress, and about the time at which the kidneys first appear, that, according to the observations of Bischoff on the mammalian embryos generally, the ovaries are first perceptible.

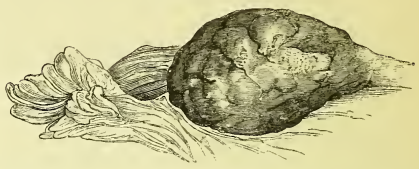
In the human embryo the ovary cannot be discerned earlier than the 5-7th week. Nor is it possible at the time of its first appearance to distinguish the ovary from the testis. Hence the term "generative gland" has been proposed by Kobelt as the most appropriate designation for a structure which, according to him, is then capable of being converted into either organ indifferently. In a human embryo of the fourth week, of which I have given a description in the Transactions of the

Microscopical Society of London *, no trace of an ovary or generative gland was discoverable, but only slight indications of two linear-shaped bodies occupying the dorsal and lumbar regions on either side of the vertebral column, representing the corpora Wolffiana. In another embryo measuring 5‴ in length, the generative gland could just be discerned in front of the supra-renal capsules and kidneys, but its form could be only indistinctly traced. In an embryo, however, which measured 8′′ in length, the gland had already assumed distinctly the elongated figure characteristic of the early formation of the ovary. It measured 0·8‴, and its position was oblique, or intermediate between the perpendicular direction of the Wolffian body and the horizontal one of the fully formed ovary. In an embryo of three months the generative gland or ovary still retained the oblique direction. Its length was 2‴, and its breadth 0·4‴.

From this period the gland, which now begins to assume more decidedly the character of an ovary, gradually acquires the horizontal position in which it is found at birth (*fig.* 440.). In the fœtus at term the ovary has usually attained a length of 4-5‴, and a breadth of 1½-2‴ (*fig.* 441.). Its figure is an extended oval, with flattened sides and base. These meet to form a triangle, whose basal margins are sinuous and sometimes indented. At the age of three years, (*fig.* 442.) the ovary attains a length of 10-12‴, still however preserving its elongated form, with irregular or slightly indented margins. This peculiarity of a fœtal condition the ovary gradually loses as the period of puberty approaches, when it grows more rapidly and acquires the form and dimensions already described as characteristic of the mature organ (*fig.* 369.). At this period of life, however, no feature of the ovary is more subject to variation than its form. Even for some time after the catamenia have been established, the elongated figure is often seen to have been retained, although the rounded or gibbous outline is more commonly observed by the time that adult age is attained.

The ovary is now full and plump ; its surface up to the time of puberty has remained uniformly smooth, even, and shining, and its investing tunics are unbroken.† But it has been seen that, from puberty onwards, through these two tunics of the ovary, the ova periodically escape by a process of dehiscence, resulting from an absorption and rupture of these tunics. The effect of these repeated lacerations is twofold. The surface becomes scarred in all directions by the closing up of

Fig. 390.



Ovary about the time of cessation of menstruation. (*Ad Nat.*)

the lacerated openings, whilst the successive discharges of the contents of the ovisacs gradually diminish the bulk of the entire organ (*fig.* 390.). In proportion as age advances, these cicatrices and indentations become still more numerous, and the once smooth and plump ovary is converted into a small corrugated wrinkled body full of pits and tortuous

Fig. 391.

Ovary in old age. (*Ad Nat.*)

lines (*fig.* 391.). When sections are made of the ovary in this condition, it is found that all traces of the Graafian follicle have disappeared; or one or two only may be observed, degenerated into little masses or sacs of cartilaginous hardness. More commonly, however, nothing now remains but a dense parenchyma.

Besides these changes in the form of the ovary and the condition of its component parts, great alterations also take place in its vascular supply. In early life, and especially from the establishment of puberty up to the critical age, the organ is abundantly supplied with blood-vessels, which are seen everywhere both in the proper parenchyma of the ovary, and also upon the walls of the ovisacs. These have been described as undergoing enlargement, and probably increasing in number in the neighbourhood of the spot at which the rupture of the follicle occurs. Not only, however, is there a local hyperæmia in these situations at each recurrence of the ovipont, but the entire ovary receives a larger supply of blood on these occasions. But when the process of ovulation has entirely ceased, the tissues begin to suffer the wasting of age, the ovary partakes in the general state of pallor of the other pelvic viscera, and the ovarian vessels carry only as much blood as will suffice for the bare nutrition of the shrivelled organ.

* Vol. iii. part ii. p. 65.

† In reference to the human subject, the universally received opinion regarding the discharge of ova by rupture of the ovisac, as an occurrence which commences only at or after puberty, has been called in question by Dr. Ritchie, who, after detailing a series of observations upon the condition of the ovary at various periods of life, asserts that "the Graafian vesicles contained in the ovaries prior to menstruation are found, as they also are in every other period of life, in continued progression towards the circumference of the gland, which they penetrate, discharging themselves by circular-shaped capillary-sized pores or openings in the peritoneal coat; the presence of the catamenia being thus no indispensable prerequisite to their rupture." [1] It should be observed, however, that the facts adduced by Dr. Ritchie do not appear to bear out very clearly the conclusions which he has drawn from them.

[1] Lond. Med. Gaz., vol. xxxiv. p. 253.

Abnormal Anatomy of the Ovary.

Effects of extirpating the Ovary.— A natural deficiency of the ovary together with the oviduct of one side is known to prevail in the class *Aves*, but this deficiency, which is occasioned only by a want of development of one half of the generative organs previously existing entire in the embryo, does not affect the reproductive power of birds.

Mr. Hunter, wishing to determine the effect of extirpating one ovarium upon the number of young produced in Mammalia, procured two young sows of the same farrow, and having removed a single ovarium from one of them, he kept both animals under the same circumstances, in order to observe the comparative effects of breeding upon them.

They commenced breeding when two years old. The spayed animal took the boar earlier than the perfect female, and both continued to breed at nearly the same times.

The spayed animal continued to breed until she was six years old, and in that time she had eight farrows, producing in all seventy-six pigs, but she did not take the boar afterwards. The perfect sow continued breeding until she was eight years old, and had thirteen farrows, yielding one hundred and sixty-two pigs. She then ceased to breed. The result therefore of this experiment was, that the perfect animal continued to breed two years longer, and produced in all ten more than double the number of the spayed one, although she had not double the number of farrows.

But few opportunities have occurred for observing the effects produced by the removal of the healthy ovaria upon the human female.

The case in which Mr. Pott removed both these organs at the same time constitutes the best example on record.

A young and healthy woman, twenty-three years of age, was received into St. Bartholomew's Hospital, on account of two small swellings, one in each groin, which had for several months been so painful as to prevent her from following her occupation as a servant. The swellings, which were not inflammatory, were soft, uneven upon their surface, and moveable. They lay directly upon the outside of the tendinous opening of the oblique muscle through which they appeared to have passed. The woman was in full health, was large breasted, and menstruated regularly. On account of the inconvenience occasioned by the presence of these tumours in the groins, Mr. Pott was prevailed upon to remove them. They were found upon examination to be the two ovaria which had descended in the form of a double inguinal hernia. The woman subsequently enjoyed good health, but became thinner and more apparently muscular; her breasts, which were large, were gone, nor did she ever menstruate after the operation; the last observation of her having been made several years subsequent to that event.*

Deficiency of the Ovary. — Complete congenital absence of both ovaries, except in the case of the non-viable fœtus, is of extremely rare occurrence. It is almost always associated with deficiency or imperfect formation of the uterus, and generally with incomplete development of the vagina, nymphæ, clitoris, and mammæ. The sexual appetite in these cases is wanting. Menstruation is absent; the secondary sexual characters are but feebly expressed, and there is of necessity a total inaptitude for reproduction.

The ovary may, however, be deficient on one side only, without any of these accompanying conditions. There may be nothing externally to mark the defect, nor is there necessarily here any impediment to the exercise of the sexual function.

Arrest of Development. — The ovary, like the uterus, long retains its infantile condition, but as the period of puberty approaches it expands and soon attains its full size. This change, however, may not occur. The ovary may cease to grow after the third or fourth year, and, under these circumstances, the whole organism manifests a corresponding tardiness of development. An interesting example of this is preserved in the museum of King's College. The preparation consists of the entire internal organs of a young woman who died at the age of nineteen without having menstruated. The ovaries, as well as the rest of the organs, are no larger than those of a child of three years (see *fig.* 465.). In these cases the mammæ are small, the external organs only partially developed, and the whole frame is formed upon a feeble scale.

Atrophy and Hypertrophy. — Atrophy has been shown to be one of the conditions at which the ovary inevitably arrives when a certain period of life is passed. It is under these circumstances a normal condition, just as the state last described is also a normal condition when associated with a certain epoch, but both become abnormal states when they occur out of their usual course. Thus, an early atrophy of the ovary on both sides will of necessity bring with it a premature failure of procreative power, although an atrophied state of the organ on one side only, like atrophy of one testis, will but little, if at all, affect this power.

Of hypertrophy of the ovary a more particular account will be given in the description of morbid growths and abnormal developments of its special parts.

Displacements of the Ovary. — The ovary, in consequence of its peculiar mode of attachment to surrounding parts, enjoys great freedom and range of motion. This is rendered most conspicuous, when, during the gradual enlargement of the gravid uterus, the ovary is carried upwards from the pelvic into the abdominal cavity. Under these circumstances the ovary certainly vindicates the character assigned to it by the older anatomists, of being an appendage to the uterus, for it necessarily follows the movements of the larger organ to which it is attached. Thus, the ovary is sometimes a pelvic and sometimes an abdo-

* The Chirurgical works of Percival Pott, by Earl, vol. ii. p. 210.

minal viscus. But it may be displaced from its normal position in either of these cavities under various circumstances. The causes of such displacements are chiefly, inflammation of the surface of the ovary terminating in adhesions, displacements of the uterus, and herniæ.

As a result of inflammation of its peritoneal covering, the ovary may be bound down to the side of the uterus, or Fallopian tube, to the recto vaginal pouch, to the brim of the pelvis, to the colon, to the convolutions of the ileum, or to the omentum.

The displacements of the uterus which occasion a dislodgement of the ovary from its normal position are, retroversion, inversion, and procidentia, or complete prolapsus.

In retroversion the ovaries are carried downwards along with the uterus into the hollow of the sacrum, where they occupy a position on either side of the principal organ. In inversion of the uterus, the ovaries, together with the Fallopian tubes, fill the interior of the artificial pouch, which is formed by the reversement of the organ; whilst in extreme prolapsus the ovaries, together with the uterus, escape almost entirely from the pelvis, and occupy the sac which is formed by the inverted vagina.

But the most remarkable displacements are those in which the ovary constitutes a true hernia. Such a hernia may consist of the ovary only, or may include other organs, as the Fallopian tubes, uterus, intestine or omentum. A true hernia of the ovary alone is of comparatively rare occurrence. It may happen on one or on both sides, and may be either congenital or acquired. The celebrated case of Mr. Pott was an example of a double inguinal ovarian hernia. And this appears to be the form under which this singular displacement has been most frequently met with. In these cases the ovary constitutes a solid tumour of the size of a pigeon's egg, which may be detained at the ring, or lie within the inguinal canal, or even descend to the labium.

An example of this kind of hernia, in which the left ovary has for many years occupied the inguinal canal, has recently come under my notice. Deneux*, who was at the pains to search out all the cases on record up to his time, has collected examples also of crural, ischiatic, umbilical, ventral, and vaginal hernia of the ovary, and to these Kiwisch has added a case of hernia through the foramen ovale.

Diseases of the Tunics.

Inflammation of the ovarian tunics, and particularly of the peritoneal coat, is most commonly associated with acute puerperal metritis. But inflammation, both in the acute and chronic form, may affect the ovary independently of the puerperal state. The resulting anatomical changes in the coats of the organ are vascular congestion in various degrees; fibrinous exudations upon their surface, followed occasionally by the formation of artificial bands or adhesions with surrounding parts; and chronic thickening of these coats, whereby the original smooth and even surface, (*figs* 368. & 369.) characteristic of the ovary in early life, is lost. When inflammation of the ovary has advanced to the suppurative stage, and this organ is converted into a bag of pus, the coats may have become so attenuated and softened as to burst when the attempt is made to lift the parts from the body after death.

Ulceration. — *Rupture.* — In the case of large collections of fluid within the ovary, as for example in large abscesses or in ordinary ovarian dropsy, the surface of the ovary frequently inflames and contracts extensive adhesions with surrounding parts, and if the latter happen to be hollow viscera, such as the intestines, uterus, or bladder, a fistulous communication may be established between them and the sac of the ovary, through a process of ulceration or absorption of the common partition wall, and the contents of the ovary may become discharged externally. Or it may happen that by a similar attenuation and rupture, or by a process of ulceration and absorption of these tissues, the ovarian walls give way, in some parts of their free surface, and their contents escape into the abdominal cavity.

Hypertrophy of the ovarian tunics is almost constantly observed in considerable enlargements of the organ, from whatever cause they may arise. In the case of large ovarian cysts, before adhesions have been occasioned by the pressure of surrounding parts, the peritoneal coat of the ovary, though much thickened, retains its smooth, shining, external surface. It may be generally stripped off with ease, and displayed as a dense white membrane of unequal thickness, but having undergone no further change than that of a general hypertrophy of its ordinary component tissues. The tunica albuginea in like manner becomes thickened by simple increase of its ordinary constituents, but in the case of very large, and particularly of unilocular cysts, the cyst wall becomes so intimately blended with the common ovarian investment, that it is impossible to determine how much of the now united membranes was originally furnished by the tunica albuginea, or ovarian stroma, and how much by the proper wall of the cyst. The hypertrophy in these cases is often so considerable that the boundary walls of a large ovarian cyst may measure one or two inches or even more in thickness in some places.

Ossification. — Patches of ossific matter more or less extensive are occasionally found scattered over the surface of ovarian cysts. It is probable, however, that these are deposited in the first instance upon the inner surface, or in the proper walls of enlarged cysts, and subsequently extend to the proper coverings of the ovary, and that the fibro-cartilaginous degeneration which these cyst walls sometimes exhibit, also commence in the original cyst, and proceed from within outwards.

Diseases of the Tissues.

Hyperæmia of the ovary may be limited to

* L. C. Deneux, Recherches sur la Hernie de l'Ovaire. 1813.

the parenchyma, or to the walls of particular follicles, or may affect all these parts together.

Hyperæmia of particular follicles, with considerable enlargement of the sac and effusion of blood into the cavity of the follicle, is not unfrequently observed as an abnormal condition. But hyperæmia of single follicles with effusion of blood into the cavity has been already described, as being also a natural state of the Graafian follicle, which is preparing for dehiscence and discharge of an ovum.*

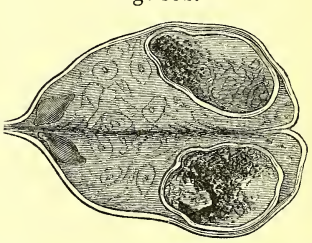
It may be asked, therefore, in what respect does the normal differ from the abnormal state, and by what characteristics may the one be distinguished from the other? It appears to me that Rokitansky, in the account which he has given of hyperæmia of the Graafian follicle †, has included under one head both the natural and the morbid condition; for his description will very well apply to the rising follicle, in its second stage, when the escape of blood into the cavity has been shown to be a normal, and in some animals a constant occurrence. The presence, therefore, of blood within the follicle, for the reasons already fully given (p. 556.), must not be regarded as necessarily affording evidence of a morbid state. There are, however, certain peculiarities in the condition of the unhealthy follicle, by which it may be distinguished from that which is natural. The natural follicle, when preparing for dehiscence, is always near the surface, and often projects considerably above the level of the ovary (*fig.* 380.). Its coats are unequally thick; the thinnest portion being always found at the most prominent point of the follicle. There is considerable vascularity about this point, plainly visible externally, and here the process of attenuation and absorption continues to be progressive until the sac spontaneously ruptures. The walls of the follicle are at this stage of a *bright yellow colour*. The liquor folliculi is either clear and limpid or intermixed with blood, or the centre of the sac is filled by a coagulum, which is at first bright red, and afterwards becomes pale, and at length nearly white. The coagulum may adhere to the walls, and undergo fibrillation and subsequent conversion into a solid body, or into a dense white membrane, or it may be rapidly absorbed.

On the other hand, the morbid follicle, although it may not exceed nor even equal in size that which is passing through its normal changes, may yet be distinguished by many characters which are the converse of those just described. The morbid follicle is often not peripheral, but is more or less central in its position in the ovary. It may attain to the size of $\frac{1}{3}$ or $\frac{1}{2}$ of the ovary, without necessarily causing any distinct prominence above the surface (especially when occurring singly). The walls are equally thick, and exhibit at no part any evidence of attenuation or absorption. No preparation for rupture is indicated externally by any peculiar arrangement of vessel, or by any marked increase of vascularity. The walls do not exhibit the remarkable yellow colour nor the cerebral foldings characteristic of the advancing normal ovisac, but the tissues of which they are composed are simply those of the undeveloped Graafian follicle. The contents of the sac are neither the clear liquori folliculi, nor the bright clot, nor the decolorised fibrin, but generally a collection of dark coffee-ground matter, resulting from the admixture of a quantity of decomposing blood-corpuscles and fragments of membrana granulosa intermixed with a dirty fluid. On washing out these contents, the walls of the cyst, if the ovary has been injected, are seen to carry numerous vessels, irregularly arranged, but never presenting that rich network of capillaries which are visible after a successful injection of a healthy ovisac progressing towards rupture, especially in those cases where the quantity of yellow oil is not so great as to obscure these vessels altogether.

By these characteristics the morbid ovisacs may generally be distinguished from those which are healthy. There is enough of similarity between them to prove their identity of origin, and enough of dissimilarity to show their divergence from a common starting point; the healthy follicle proceeding onward through a course of different changes, which have been already fully described; the morbid follicle exhibiting an apparently unlimited power of growth and deformity, such as will be presently more fully noticed.

Fig. 392. exhibits the morbid follicle in one of its earliest stages of growth. It may be contrasted with *figs.* 381. and 385., for the purpose of showing the points of difference which have just been described. In *fig.* 392. the morbid follicle occurs as a single cyst in the midst of

Fig. 392.



Ovary containing a morbidly distended Graafian follicle in an incipient stage. The rest of the organ is healthy. (*Ad Nat.*)

otherwise healthy tissues. Although occupying more than $\frac{1}{3}$ of the entire ovary, it scarcely disturbs the even outline of that organ. Its coats are of uniform thickness throughout. There is no attenuation nor preparation for dehiscence at any particular spot, nor external sign of increased vascularity in one point. But the walls of the follicle contain numerous vessels, distributed nearly equally over their surface. The cavity is filled with loose flocculi of a dark chocolate colour, consisting of decomposing blood clot mixed with patches

* P. 556.

† Manual of Pathological Anatomy. Sydenham Society. Vol. ii. p. 328.

of membrana granulosa. The walls of the follicle are not yellow, and contain no oil globules. They are slightly thicker than those of the healthy follicle. Their component tissues are precisely those which have been already described as characterising the ovisac in its normal condition; the chief bulk of their texture being made up of granules and embryonic fibres intermixed with a few developed fibres of ordinary white fibrous tissue.

Such a condition may, for want of a better designation, be regarded as hyperæmia of the follicle, or it might perhaps be more appropriately termed hypertrophy of the follicle; but in whatever light it may be regarded, it constitutes one of the early stages of those enormous growths, of which more will be said hereafter.

A more extensive form of congestion, affecting the parenchyma of both ovaries, and associated with a like hyperæmic condition of the uterus, may be sometimes observed about the period of the final cessation of menstruation. The ovaries are then occasionally found of an intense red colour, from the parenchyma, as well as the follicular walls, being deeply loaded with blood. The most marked instances of this I have observed in connection with cardiac disease, and associated with congestion of other organs.

Inflammation of the Ovary.— Ovaritis.— Oophoritis.—Our knowledge of the pathological changes which the ovary undergoes as the result of inflammation, is chiefly derived from examination of the bodies of women who have died of acute puerperal metro-peritonitis. But unquestionably inflammation both in the acute and chronic form may affect the substance of the ovary, independently of the puerperal or pregnant states, and cause various degenerations of the tissues of that organ, as evidenced by those serous, fibrinous, and puriform deposits, or general softening of the ovarian parenchyma, which are occasionally found after death. It is probable also, from symptoms displayed during life, that inflammation, especially in a chronic form, not unfrequently attacks the ovary and terminates in resolution, or in those milder results of inflammation which consist in temporary induration or enlargement of the organ, unaccompanied by serious disintegration of its tissues.

It must, however, be observed with regard to the evidences of inflammation of the ovary either in the acute or chronic form, which are supposed to be afforded during life, consisting in pain and tenderness referred to the seat of that organ, or in obvious enlargements of the ovary, as discoverable by various modes of internal or external tactile examination, and conjoined with more or less constitutional disturbance, that these signs may and do often in the non-puerperal state, accompany the natural process of ovulation, and that such symptoms, recurring with each menstrual period, may affect a woman at intervals in a greater or less degree during the whole of that period of life in which she is capable of child-bearing. But in the present state of our knowledge of ovarian processes it is perhaps not possible to determine how much of these symptoms may be regarded as evidence of a natural, and how much of a morbid change in the part; for although in many women the process of ovulation is continually performed without consciousness of local suffering, yet in a great number of instances the act is accompanied by much pain, and there can be no question that the cause of much of this suffering is to be looked for in the changes which the tissues of the ovary undergo in the act of expelling the ova.

How closely this process in its more obvious conditions is allied to inflammation has been already shown. A high degree of vascularity of the part, with increased exudation of fluid, and consequent enlargement and tension of the entire organ terminating in spontaneous laceration of its coats by a process very similar to ulceration, and often accompanied or preceded by a more or less considerable escape of blood: these together form a combination or series of processes closely allied in their nature to inflammation, and frequently evidenced externally by signs usually regarded as characteristic of inflammatory action.

Nor is it yet known how far these symptoms, which have generally been assumed to indicate ovarian inflammation, especially in a chronic form, may be merely the external evidences, not of natural, but of aberrant or disappointed ovulation. For just as an abscess is painful generally in exact proportion to the unyielding nature or tension of the parts by which it is surrounded, so it is probable that when the follicle or the entire ovary becomes tense from the effusions which have been shown to have taken place ordinarily within it, and this tension is not relieved because rupture does not occur at the proper time, so that ovulation is disappointed or is aberrant, the symptoms which might be expected to accompany such an interrupted process would be those which are usually set down as indicating inflammation in a part.

This matter appears hitherto to have been hardly thought of, and yet it is probable that to *abortive or interrupted ovulation* may be referred the commencement of many of those morbid conditions of the ovary which are not either malignant or the direct results of inflammatory action. Probably many of the cystic diseases of the ovary originate in this way. Of disappointed ovulation, as it may be observed in animals, instances have been given at page 568. Here the follicles, although apparently preparing for rupture, were arrested in their progress from some unexplained cause; and although it may be conjectured that such follicles might, under an increase of stimulus, accomplish their final purpose, as Coste has supposed in reference to the instance just quoted, yet it has been shown by the researches of Barry that multitudes of ovisacs perish without accomplish-

ing that purpose at all, and it is probable that these, in preference to other and more healthy follicles, become the seat of subsequent morbid changes.

For it must be remembered that the circumstances under which the male and female generative elements escape from the place of their original formation are essentially different. The male secreting organ, the testis, is provided with an excretory duct for the escape of the fertilising fluid; but the female gland is a shut sac. To the normal escape of its products many barriers are opposed, and it has already been shown by what complicated machinery the shedding of the female product is effected. But it is impossible to regard this complex process without perceiving how easily a failure in any of those steps may defeat the final object for which that process is set on foot. The thickness of the walls of the follicle, the density of the ovarian coverings, or of the parenchyma of the ovary, if the follicle should fail to reach the surface; the chance of the ovum perishing before it quits the ovisac, and so the stimulus to the healthy development of the latter being lost; the chance of an excessive accumulation of liquor folliculi or of blood within the follicle, causing damage to the ovum, and replacing a natural by a morbid amount of exudation. In these and other possible interruptions to the natural completion of ovulation we may discover the elements of many future morbid changes. And although it would require a long continued and deep research into the aberrant functions of the ovary to determine the true order and sequence of many of these morbid processes, yet it is impossible to carry anatomical investigation into the structure of the morbid ovary, especially under incipient forms of disease, to any extent without many fragmental observations occurring suggestive of the idea that the ovary, like any other gland, may have its natural functions impeded, and that many of the organic changes which are observed in this part may owe their origin to such interrupted processes. Some of the observations which have led me to the adoption of these views have been already given, and some others will be detailed as suggestive of a better basis for the study of ovarian pathology than has hitherto been employed; for of all the organs of the body the ovary is perhaps that whose pathological conditions have been regarded with the smallest amount of reference to its natural or deranged *functions*.

From these considerations, then, I have been led to the conclusion that certain conditions of the ovary, which, from their concomitant symptoms during life have been deemed inflammatory, are not necessarily associated with inflammation; that it is probable, first, that the natural process of ovulation is often accompanied by symptoms very similar to those of inflammation; and secondly, that the process of ovulation is occasionally disappointed or interrupted, and that the follicles, whose natural development has been interrupted, may, like the hydatiform placenta, become the seat of a low form of nutrition, terminating in effusion and collection of various dropsical fluids.

With regard to the anatomical evidences of inflammation of the ovary as furnished by post-mortem examination, they are chiefly the following, viz.: general redness or hyperæmia of the ovarian parenchyma, or of the walls of the follicles; swelling of the ovary to the extent of increasing the organ to three or four times its natural size, producing a round, oval, or flattened form of the ovary; a general tension or hardness of the organ in the early stages of inflammation, and subsequently softening, consequent on degeneration of the tissues and their infiltration by serous or puriform effusions; and lastly, but rarely, gangrene of the ovary.

Of these morbid changes the only one which appears to require a more particular account is

Suppuration of the ovary. Pus may be found in a circumscribed cavity within an enlarged and highly vascular ovary, portions of whose structure may still retain its natural condition. Or the entire ovary may be converted into a bag of pus, the natural tissues being entirely destroyed, and the fluid bounded only by the ovarian tunics. In such cases the abscess "appears to rise from suppuration in the substance of the viscus, similar in every respect to phlegmonous abscess in any part of the body, and not connected with any cyst, or change, or addition of structure, the product of morbid growth."* These abscesses, which are sometimes of enormous size, may burst into the general sac of the peritoneum, or, after forming adhesions with surrounding parts, may discharge their contents externally through the abdominal walls, or into the Fallopian tube, uterus, vagina, bladder, rectum, or other part of the intestine. Portal mentions cases of ovarian abscess as large as an infant's head, and Dr. Taylor† of Philadelphia has recorded an instance in which the ovary contained twenty pints of pus. It is highly probable that these and even still larger collections of pus, which have been found in the ovary, were, as M^me^ Boivin has suggested, originally cases of encysted ovarian dropsy, but inflammation and suppuration having been set up in the walls of the cyst, the original contents have been gradually intermixed with pus, until the whole fluid has appeared to be of that nature. Probably of this kind also was the case recorded by Vater‡, in which the ovary was as large as the human head, and "contained pus distributed into several capsules." This, therefore, was a multilocular abscess.

Except in connection with acute metro-peritonitis, suppuration of the ovary may be considered as comparatively rare. Dr.

* Seymour's Illustrations of some of the principal Diseases of the Ovaria, p. 40.

† North Amer. Med. & Surg. Journ. 1826.

‡ Haller, Disp. Med.

Hooper* "met with only two instances of abscess" of this organ. "The one was the size of a child's head at birth, the other not larger than an orange. There was nothing in these different from common abscesses; the whole of the internal substance of the ovaries was gone, and the walls were formed of a thick and rather ligamentous cyst, covered by peritoneum." Suppuration occurs also occasionally in those cysts of the ovary which contain hair and teeth, together with other imperfectly formed products. To the same class of suppurative diseases should also probably be referred that singular morbid condition of the part in which the entire ovary is reduced to the state of a diffluent pulp, of a yellow or brownish-green colour, of the consistence, and having somewhat the appearance of very soft putty, immiscible with water, and retaining sufficient tenacity to preserve its semifluid character, and yet not having firmness enough to admit of the part being preserved as a preparation. Of this morbid condition of the ovary, which, however, may possibly be cancerous, I met with a striking example in a case of sudden death occurring in the seventh month of pregnancy. Both ovaries were of the size and form of a bullock's kidney, their natural structure was entirely destroyed, and was replaced by the soft substance just described. The circumstance that both ovaries were thus affected renders it evident that the disease could not have existed in any great degree at the time of impregnation, or that it certainly must have been then limited to one organ.

From the comparatively scanty materials extant relating to ovarian abscess it may be concluded, that suppuration may either commence at separate parts of the parenchyma, forming small collections of matter, which gradually coalesce, or it may be set up throughout the whole of the stroma at once. In these cases the parenchyma of the ovary is gradually consumed, and the organ is converted into a purulent cyst.† Whilst in other cases the Graafian follicle appears to be the seat of the suppurative action, which may either commence originally in the walls of one or more follicles constituting circumscribed abscesses of moderate size, or the suppurative stage of inflammation may be established in the walls of a follicle already considerably enlarged, and thus an ordinary ovarian cyst, with simple transparent contents, may be gradually converted into an abscess of enormous magnitude.

Cysts.—A complete anatomical description of the numerous forms of cystic disease which affect the ovary would occupy a far larger space than the limits of this article will permit. On this account the more important varieties only can be noticed. These are chiefly Simple cysts, Compound cysts, Hydatid cysts, Demoid cysts, or those containing fat, hair, teeth, and bones, and Colloid cysts.

Simple Cysts.—The simple, barren, or unilocular ovarian cysts are composed, as their name implies, of a single sac, which, according to its size, occupies the interior of the ovary, whilst the rest of the organ retains its normal condition; or else the cyst, by enlarging, presses aside and distends the parenchyma and tunics of the ovary, which thus form a common boundary to the sac, or the cyst, having originated in one extremity of the ovary, grows at the expense of that portion of the organ, whilst the rest, retaining its natural structure, becomes by degrees a mere appendage of the sac, and may be seen projecting in the form of a small button-like prominence from its outer surface.

These cysts vary in size from that of a pea to the bulk of the adult head; they rarely, however, attain the latter dimensions without becoming proliferous or multilocular, and they appear never to acquire as single cysts the enormous bulk which the compound cysts not unfrequently exhibit. This more moderate size of the single cyst is less frequently productive of those adhesions with surrounding parts which the pressure of the larger compound cysts so commonly occasions. Hence the precise locality of the single cyst, and its origin in the substance of the ovary, can generally be determined without difficulty. The distended sac is found hanging as an appendage to the ovarian ligament, whilst the Fallopian tube is often seen partly spread out over its surface, one of the fimbriæ being always closely adherent to the sac, and conducting the observer infallibly to any portion of the original ovarian structure which may have remained yet unchanged.

The coats of these cysts vary much in density and thickness. Those of the single kind are more uniform throughout; they are generally thickest towards the base or seat of their vascular supply. Here they vary in thickness from 2‴ to 12‴, but become much thinner in other parts, so as at times to be nearly transparent. The outer coat always consists of peritoneum, which is smooth and shining upon its surface, except when adhesions have been formed with surrounding parts, or when fatal peritonitis has occurred, as from bursting of the sac. The condition of this coat has been already described under the head of morbid states of the ovarian tunics. The variations in its thickness are not generally so considerable as materially to affect the bulk of the sac.

The middle or intermediate coat is that generally upon which the greater or less density of the cyst wall depends. This coat is usually of a brownish-yellow colour, and firm fleshy texture. It is with difficulty split into a number of rough-surfaced laminæ, exhibiting to the naked eye a coarse fibrous arrangement of their constituent parts, which, under the microscope, are seen to consist of inelastic fibrous tissue, mingled with granules, and undeveloped fibre cells in varying proportions.

* The Morbid Anatomy of the Human Uterus and its Appendages, p. 3.

† Rokitansky, Path. Anat. vol. ii. p. 331. Syd. Soc. edit.

To this coat, which appears to retain or increase its thickness by a perpetual new formation of fibrous tissue, is due that support and resistance to the pressure of the increasing contents of the sac, which prevents the more frequent rupture of these cysts. And it is probable that when the latter phenomenon occurs, without the formation of previous adhesions, followed by ulceration, the laceration is due to the gradual attenuation of the middle wall of the sac.

Occasionally portions of these walls are found to be of nearly cartilaginous hardness, so that they can with difficulty be broken up into fragments for minute examination. Such portions are seen under the microscope to be composed almost entirely of close-lying fibres of white fibrous tissue, with scarcely a trace of the embryonic fibres and granules, which are found abundantly in the walls of the softer cysts, and of the normal ovisac. Other portions of these cyst walls, still more dense, present to the naked eye, as well as under the microscope, all the characters of the simpler forms of cartilage; whilst in the walls of other cysts again are found patches of ossific matter, in which the earthy elements of bone are aggregated together, (calcification) but without the definite arrangement characteristic of true osseous structures.

Upon and in the substance of this middle coat ramify numerous arteries and veins, sometimes of considerable magnitude. These distribute their minute branches upon the inner surface of the cyst, where they occasionally present a peculiar straight or rectangular arrangement. Doubtless these vessels are the carriers of those enormous collections of fluids which accumulate within the cysts, and upon their arrangement, as well as upon the nature of the epithelial lining of the sac, depends probably the character of the fluids secreted or effused.

Most variable is the condition of the lining membrane which bounds the inner surface of the cyst. In the smaller cysts it is often composed of one or more layers of simple flattened epithelial cells; the remains, perhaps, of the membrana granulosa. This surface may be free, or to it may adhere fragments of blood clot, degenerating or undergoing fibrillation, by which the sac, when small, is partly filled. This lining of epithelial cells is often seen in a state of fatty degeneration*, and similar cells are found abundantly scattered among the contents of the sac.

In the larger and older cysts the membrane lining the sac is nearly as smooth as that which covers it externally. In these the lining membrane often exhibits but little vascularity, and shows small traces of an epithelial covering in its smoother parts, where it is usually so intimately adherent to the middle walls, as to be separable from the latter only with difficulty. Fragments so obtained are easily split up, and are seen to be composed of developed fibres of connective tissue, intermixed with fine granules and a few embryonic fibres.

After the simple cyst has arrived at a certain period of its growth, and generally when it equals the size of a large orange, it begins to exhibit upon its inner surface patches, more or less extensive, of rough projections, granulations, or vesicles, which will be described more fully under another section.

Multiple Cysts.—I have employed this term to designate a variety of the single cyst which might be confounded with the compound or proliferous kind, and which consists merely in an aggregation of two or more simple cysts that have been contemporaneous in their growth. The distinction between a mere aggregation of simple cysts and the growth of a compound one has been carefully drawn by Rokitansky*, and has been also illustrated by Paget.†

If such cysts are observed at an early period of their growth, they may be seen to occupy different portions of the ovary in which they arise independently of each other, and having distinct portions of ovarian stroma interposed between each. They have at first a round or oval form, but "as they all enlarge together, and sometimes by the wasting of their partition walls come into communication, they are flattened by reciprocal pressure, and "may at length look like a single many-chambered cyst, having its one proper wall formed by the extended fibrous covering of the ovary. Many multilocular cysts, as they are named, are only groups of close-packed single cysts; though when examined in late periods of their growth, and especially when one of the group of cysts enlarges much more than the rest, it may be difficult to distinguish them from some of the proliferous cysts.

Figs. 392. and 393. serve to illustrate the simple and the multiple cyst respectively. *Fig.* 392. has been described at p. 575, where this example is given as an instance of hypertrophy of a Graafian follicle in an early stage, forming a simple or unilocular cyst, still hardly contained within the substance of the ovary. It will be seen that at one part of this preparation the wall of the cyst has become blended with the general investments of the ovary; and it will be easily understood how, by the gradual enlargement of the cyst in this direction, where there will be the least amount of resistance to its growth, the sac may at length become so greatly expanded that the remaining healthy portion of the ovary will appear only as an appendage to it, or may become by pressure and extension altogether obliterated. *Fig.* 393., taken from Dr. Hooper's collection‡, offers a good example of the multiple cyst. It is composed of a mere aggregation of simple or unilocular cysts, which, by coincident enlargement, have come at length to fill the entire ovary, causing considerable increase in bulk of that organ. From the right ovary (*a*) a portion has been removed

* Wedl, Patholog. Histol. p. 461. Syd. Soc.

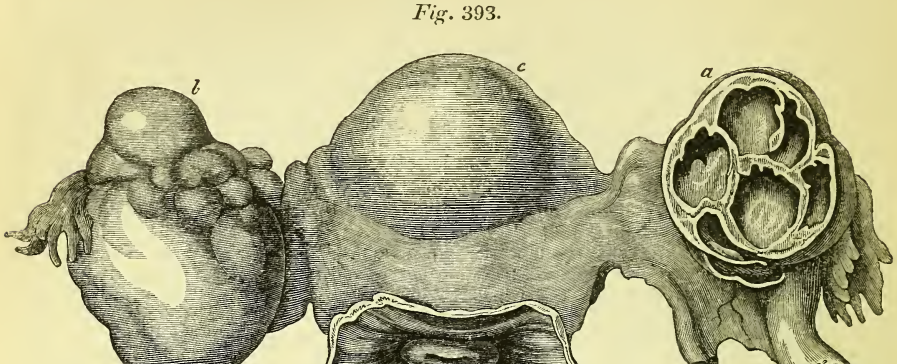
* Loc. cit. p. 332.

† Lectures on Surgical Pathol. Vol. ii. p. 56.

‡ Morbid Anatomy of the Human Uterus.

exhibiting a section of several simple cysts of nearly equal size; whilst the left ovary (*b*) shows a similar alteration of texture, the organ being still unopened, and exhibiting numerous small sacculi which have here begun to project above the surface.

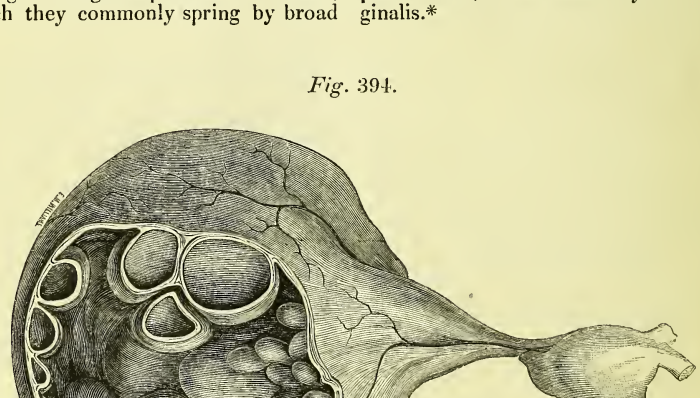
Fig. 393.



a, right ovary, exhibiting numerous unilocular cysts, consisting of enlarged Graafian vesicles; *b* left ovary similarly affected, but unopened; *c*, uterus. (*After Hooper.*)

Multilocular, Compound, or Proliferous Cysts.—In these a second, or, it may be, a third, order of smaller cysts are developed, within or upon the walls of a larger or parent sac. From these walls the secondary cysts, at a comparatively early period of their growth, are seen projecting inwardly in hemispherical form, arranged along the parietes of the sac, from which they commonly spring by broad bases. These secondary cysts are invariably and permanently attached to and continuous with the walls of the superior cyst. They are covered by a continuation of the same membrane which lines the principal sac, and which is reflected over them in the same manner that the heart is invested by the reflected pericardium, or the testis by the tunica vaginalis.*

Fig. 394.



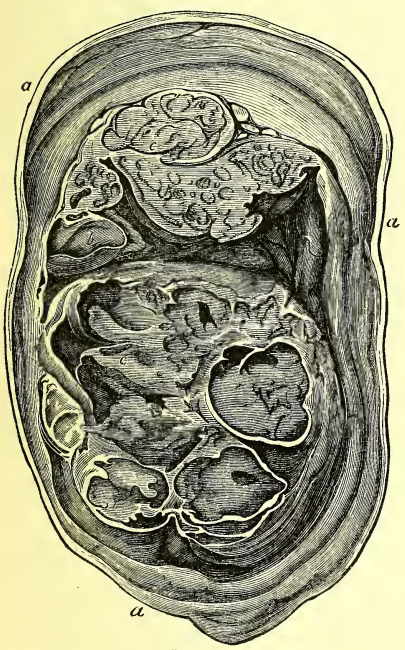
The left ovary distended into one large cyst, into the interior of which project numerous smaller cysts of a secondary order. To the right of the figure is the uterus. (*Ad Nat.*)

* Hodgkin, Lectures on Serous and Mucous Membranes. Lect. viii.

The growth of these secondary cysts with broad bases, of which a good example is exhibited in *fig.* 394., is often very irregular, so that one or more of them enlarging with greater rapidity than the rest, encroach upon the cavity of the containing cyst, and fill it more or less completely. This rapid enlargement of the secondary cysts also occasionally causes rupture of their walls and the escape of their contained fluids into the parent cyst, followed by the unrepressed growth of the secondary or tertiary cysts which arise from its surface.

After the appearance of a tertiary order of cyst within the secondary ones, their growth occasions so much disturbance of the even outlines of the walls in which they originate, that it is often difficult to trace the order and manner of enlargement of the different series. Nevertheless, with care, these may be often made out even in the complex forms, of which *fig.* 395. furnishes an example. Here is represented a small portion only of an enormously enlarged ovary, consisting of a primary or principal sac, the greater part of which has been cut away, so as to leave a part of its walls visible at *a*, *a*, *a*, and of a more solid basis which was made up of numerous secondary

Fig. 395.



Compound or proliferus ovarian cyst. (*Ad Nat.*)

a, *a*, *a*, divided walls of the principal single cyst; *b*, small simple cyst; *c*, *c*, two masses of compound secondary cysts, containing many of a tertiary order.

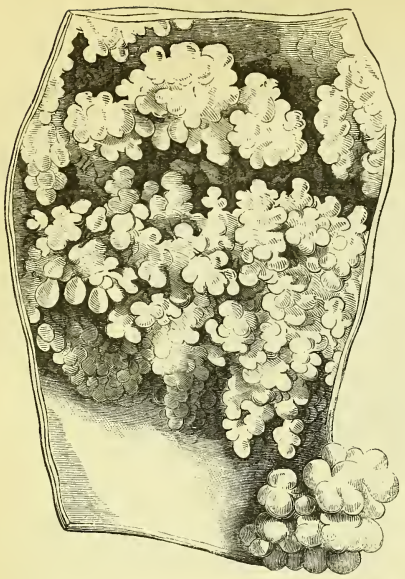
and tertiary cysts. Both of these orders may be traced in this example. At *a*, *a*, *a* are seen the divided walls of the original parent cyst, whilst springing from these walls at *b* is a single secondary cyst, and at *c*, *c* are two groups of similar cysts aggregated in masses. The latter are, however, examples of compound secondary cysts, for in the interior of each is contained a series of a tertiary order, which are so numerous as to fill completely the secondary sacculi. By Lebert it is deemed to be still an open question whether these cysts, which apparently spring from the interior of the main sac, as represented in *figs.* 394. and 395., are altogether new formations, or whether they were not originally in part developed, and by force of pressure, arising from contiguity of situation, have penetrated and at length grown within the principal cyst, into the interior of which, in this view, therefore, they would form a species of hernia.

Dr. Hodgkin *, whose elaborate descriptions of ovarian cysts has made known all the principal varieties of form which they assume, distinguishes from the broad-based cysts, already noticed, those which arise by narrow or slender peduncles. These sometimes grow from the walls of the principal cyst, and, indeed, in almost all cases which I have examined, after the sac has attained a certain size, patches of these pedunculated sacculi may be observed scattered over the interior in various places, but they are more constantly observed growing from the interior of the secondary cyst. These little sacculi appear at first in scattered patches, under the form of little round grains, thickly covering the lining membrane which they raise above them, and so closely set that two or three hundred may sometimes be counted in the space of a square inch. When these elongate, mutual pressure causes them to assume a filamentous condition; but when greater freedom of growth is enjoyed, their extremities commonly dilate into little pouches, or buds of another order sprout from the sides and extremities of the original growths, and convert them into a multitude of little dendritic processes which roughen the inner surface of the larger cysts, or fill more or less completely the cavities of the smaller ones.

If a section be made of these dendritic processes, they are seen usually to be solid at their base, the white fibrous tissue of the parent cyst wall, from which they spring, being easily traced into their stems and branches. But at their extremities they become dilated into little pouches filled with fluid, similar to the little pediculated cysts, with which they are abundantly intermixed. These little cysts and processes are covered by epithelium, and it is probable that they are the active agents in the elimination of the various fluids by which the ovarian cysts, of whatever order, are commonly filled. These minute processes and vesicles, so abundantly found on the walls of endogenous cysts, are represented in *fig.* 396., which exhibits a portion of a proliferous cyst of the natural size, covered by them on its inner surface.

* Loc. citat. and Med. Chir. Trans. Vol. xv. pt. ii.

Fig. 396.



Part of the thick laminated wall of an ovarian cyst, covered on its inner surface with pyriform vesicles. (After Paget.)

The Contents of Ovarian Cysts.—No cystic formations in any part of the body present such a variety of contents as those which are found in the ovary. These vary in every degree of consistence, from the thinnest fluids to the hardest substances, such as teeth and bones. They may be subdivided according to their densities and different degrees of organisation. And first may be considered :—

The Fluid Contents of Cysts.—The thinnest fluids are usually obtained from unilocular cysts, which have not been previously tapped. The fluid so procured is commonly of a pale straw colour, and resembles in general character the ordinary fluid of ascites. It is to these cases that the term "encysted ovarian dropsy" is most commonly applied. The contents of multilocular cysts are often less fluent, presenting every variety of consistence from a thin gelatinous fluid to one of the density of white of egg, of honey, of thin size, or of soft glue. In the latter cases the tenacity of the fluid is often so great that it may be drawn out into long strings, and it is only in this way that it can be extracted through the canula. All these varieties, which commonly retain more or less transparency, may be found enclosed in different cysts within one common investment.

In other cases the contents, while retaining their fluidity, are rendered turbid or are thickened by the admixture of pus or of blood in various degrees. Thus are produced the yellow and green hues as well as the red, reddish-brown, and dark coffee-ground colours which these fluids often present; the turbid yellow and green colours being generally caused by the presence of pus, the bright red by the admixture of recent blood, and the dark brown or coffee-ground hue sometimes by the addition of blood which has been effused long enough to have undergone putrefaction, although the brown colour is not always due to this cause. Scales of cholesterine are also found intermixed with those fluids, and in the smaller cysts especially, as already stated, recent blood or the blood clot undergoing fibrillation, or breaking down by putrefaction, may be frequently noticed.

The repeated withdrawal of the contents of ovarian cysts affords the opportunity of observing that the fluid contained in the same sac often undergoes a material change in its composition. Thus, that which is obtained by a first tapping is often of the thin straw-coloured variety, whilst that which results from subsequent operations has more frequently the turbid muddy or coffee-ground character last described. This can be explained in two ways : the first, by observing that in multilocular cases there is sometimes a natural communication between the walls of the containing and the contained cysts, or an artificial communication may be established by spontaneous rupture, or by the trocar penetrating through two cysts, and thus the smaller will act as tributaries to the larger sac, and pour their varied contents into it; or secondly, inflammation or ulceration may be set up in the walls of a cyst which has been punctured, or the introduction of air, or of blood flowing into the cyst from vessels wounded during the operation may so modify the contents as to account for those successive alterations in the fluid which are very commonly observed. In the case of cysts containing pus, rough patches, apparently of ulceration, have been observed upon their internal walls.

Quantity of Fluids and Rate of Effusion.—The structure and situation of the ovary permit this organ to suffer a degree of distension which is rarely or never equalled in other parts. Probably the only limit to the increase in size of the morbid ovary, after it has risen out of the pelvis into the abdomen, is occasioned by the pressure which the spine, diaphragm, and abdominal walls exercise upon the cyst ; for the parietes of an ovarian cyst appear in most cases to possess an unlimited capability of multiplying the fibrous element of which they are principally composed, whilst the power of rapidly replacing the fluid after their contents have been drawn off, proves both the unrestricted capability of secretion inherent in the cyst walls, and at the same time the influence which pressure exerts in keeping that secretion for a time within certain limits. Numerous examples might be quoted in illustration of the immense power of growth and secretion of fluid possessed by ovarian cysts. Imhoff* records a case in which the right ovary contained 42 lbs. of fluid. Duret† met with 50 pints of water in

* Acta Helvetica, vol. i., App. p. 1.

† Mém. de l'Acad. de Chir. t. ii. p. 457.

a single ovarian cyst. And in the London Medical and Physical Journal (Aug. 1815) the particulars of a case are given in which the right ovary weighed nearly 52 lbs. But these are moderate examples compared with some of still larger growth. Camper* relates a case in which about 80 lbs. of serum were contained in the left ovary; and Douglas also one in which the left ovary held 70 lbs., besides a considerable collection of fluid in the pleura and pericardium.†

These enormous collections of fluid are generally limited to the ovary of one side, though both organs may be coincidently affected, as in the example given by W. E. L. Müller‡, who found in the body of a woman, aged 36, in the two ovaries together 140 lbs. of fluid. In what proportion either or both of the ovaries are affected by ovarian dropsy may be seen by reference to the tables of Safford Lee and Chereau. The former shows the right ovary affected 50 times, the left 35, and both together 8 times. The latter gives 109 examples of the right, 78 of the left, and 28 of both sides.

Notwithstanding the large amount of fluid which may collect within the distended ovary as shown in the foregoing examples, these yet serve to give but a feeble notion of the enormous quantities which may be effused from the walls of an ovarian cyst in the course of a lifetime, or even of a few years, when the contents are removed from time to time, and are allowed to re-accumulate. Pagenstecher§ removed, in 35 operations, 1132 lbs. of fluid, without reckoning what escaped by allowing the canula to remain. Dr. Mead's patient was tapped 67 times in five and a half years, and lost 1920 pints. Ford‖ punctured the ovary 49 times, and removed in all 2786 pints of fluid. Heidrich* in eight years punctured 299 times, and removed 3289 Berlin quarts (Berl. Maass), equal to 9867 med. pounds, the death of the woman occurring at the age of 43. And in the celebrated case of Mr. Martineau, of Norwich, in the course of twenty-five years the patient lost by tapping, in 80 operations, 6631 pints, equal to 13 hogsheads of fluid.

Composition of the Fluids contained in Ovarian Cysts.—Although these fluids usually coagulate freely in a greater or less degree on the addition of heat or nitric acid, the proportion of free albumen which they contain is usually considerably less than is found in the serum of blood; they contain, however, a larger quantity in combination with soda than is found in that fluid. According to the analysis of Dr. Owen Rees, who has examined several specimens of ovarian fluids, their chief characteristics are, a considerable excess of water and of extractives, and a deficiency of albumen as compared with the serum of blood. To the presence of a large quantity of extractives, particularly the albumen combined with soda, Dr. Rees attributes that peculiar tenacious mucoid character which these fluids so commonly possess. This is always in relation to the nature of the solid ingredients, and is quite independent of any peculiar proportions of water, to which at first it might be supposed to be due. Again, the alkaline salts obtained from ovarian fluids differ from those of blood in not containing any phosphate which can be recognised even as a trace, unless experiments be made upon large quantities for the express purpose of detecting that substance.

The following table †, by Dr. O. Rees, gives the results of the analysis of four fluids drawn from secondary cysts of an ovarian tumour, compared with an analysis of the serum of blood.

	No. 1. Clear, light straw-coloured Alkaline. Sp. G. 1017.	No. 2. Dark-coloured muddy neutral. Sp. G. 1017.	No. 3. Approaching in character to white of egg Alkaline.	No. 4. Clear straw-coloured, containing flakes of a pearly scaly-looking substance.	Analysis of the Serum of the Blood for comparison.
Water	190·9	190·70	195·2	187·7	181·2
Albumen with traces of fatty matter	4·1	4·25	1·8	7·6	16·5
Albumen existing in solution as Albuminate of Soda	3·7	3·62	1·1		0·4
Alkaline Chloride, and Sulphate, with Carbonate of Soda, from decomposed Albuminate	0·8	0·78	1·2	4·0	1·6‡
Extractive, soluble in water and alcohol	0·4	0·45	0·5	0·5	0·3
Chloride of Sodium with Carbonate, from decomposed lactate of Alcoholic Extract	0·1	0·20	0·2	0·2	
	200	200	200	200	200

* Sammlung, bd. xvi. s. 562.

† Those who are curious in these cases will find instances referred to by Meissner (Die Frauenzimmerkrankheiten, Band ii.), in which a single ovary is said to have weighed 100, 120, and 150 lbs. respectively.

‡ B. v. Siebold's Sammlung, 1812, iii. Bd.

§ V. Siebold's Journ. für Geburtsh, b. vii. St. i.s. 93.

‖ Medical Communications, vol. ii. 1790.

* Dissert. sistens Casum Memorabilem, Berol. 1825.

† From a valuable paper on Tumours of the Ovary, by Dr. Bright, in the Guy's Hospital Reports, vol. iii. p. 204.

‡ The whole of the Alkaline Salts are estimated together in the analysis of serum as indicated by the line.

So far, therefore, as these analyses may be taken to represent the ordinary composition of the more fluid contents of ovarian cysts, it may be concluded that the action performed in these cases by the walls of the cyst is the separation from the blood chiefly of the watery and saline ingredients, with the exception of alkaline phosphates, whilst the albumen is only in part removed, and none of the fibrine.

Examined by the microscope, the more fluid contents of ovarian cysts frequently exhibit flocculi, composed of patches of epithelium, more or less united together by granular matter. When gelatiniform they often contain faint oval corpuscles, or a few primitive corpuscles. Occasionally an opalescent or opaque creamy appearance is communicated to the jelly by the formation of pus corpuscles or minute granules, and sometimes the contents are wholly filamentous, and mixed with granular cells and other products of inflammation. This jelly-like matter, when consistent, presents all the characters of coagulated *liquor sanguinis*, which has not yet passed into organisation. Acetic acid develops in it, or causes to be precipitated a white membrane having all the characters of fibrous tissue. Frequently granules, cells, and filaments may be observed in it in various stages, as is the case with recent exudations from the serous membranes, or in other simple forms of hyaline blastema.*

Hydatids contained in Ovarian Cysts. — A very perfect example of this rare affection of the ovary (originally in the possession of Dr. Hooper) is contained in the Pathological Museum of King's College. It is the largest specimen of ovarian disease in that collection, and consists of an immense aggregation of compound thin-walled cysts, of the second and third order, many of the latter being stuffed full of hydatids. Several of these have fallen out of the cysts, and lie loosely at the bottom of the glass. They are of the form and average size of pigeons' eggs, and possess the usual characteristics of Acephalocysts. (Barren echinococcus vesicles?) Comparatively few cases of this form of ovarian disease are on record.

The solid Contents of Ovarian Cysts.—These consist of fatty matter, hair, teeth, and bones. Cysts containing such materials are termed dermoid cysts. They rarely grow with the rapidity, or attain the enormous bulk commonly observed in those with fluid or hydatid contents. That such cysts may, however, sometimes equal in size those of a more simple character, is shown by a remarkable example described by Blumenbach.† A girl aged 17 had a swelling of the left ovary, which after 21 years' growth measured four ells in circumference, and reached below the knees. Death occurred at the age of 38, when the sac of the ovary alone weighed 14 lbs., and contained also 40 lbs. of a thick, fatty, honey-like substance, mixed with short and long hairs, some two feet in length, and matted together in locks. Besides these the sac contained several irregular portions of bone, some of large size. In one of these were fixed six molars and one incisor tooth, completely formed. The inner surface of the sac was beset with short hairs.

The composition of these cysts, and especially of their lining membrane, will in a great measure account for the differences which are observable in their progress and mode of growth. The dropsical cysts are closely allied in their nature to serous membranes, and, like these in a morbid condition, they possess the power of separating and collecting into their cavities the thinner constituents of the blood. And as the only apparent limit to this process is the resistance offered by the walls of the sac, and the parts external to them, so the distensibility of these, and the capacity of the walls of the cyst to meet the increasing pressure by a correlative hypertrophy of its tissues, will determine the form, size, and general condition of the tumour. But the non-malignant cysts, whose contents are of a more solid nature, and possess a higher organisation, are tegumentary in their character. Their contents are chiefly tegumental products, which, once formed, have attained the limit of their growth. Such cysts, therefore, are more stationary in their character; or if occasionally they approach in bulk the watery cysts, as in the example just quoted, this arises mainly from the addition of a fluid secretion, and the necessity for circumscribing it by hypertrophy of the walls. But more often the cysts with solid contents, if they do not remain passive, contract adhesions with surrounding viscera, and by the aid of fistulous openings discharge their harder parts, such as bones, through the nearest natural orifice.

The tegumentary character of these cysts has been clearly shown by Cruveilhier*, Kohlrausch †, Lebert ‡, and Paget. § "Upon their inner surface is produced a growth of skin, with its layer of cutis, subcutaneous fat, epidermis, and all the minute appended organs of the proper hairy integument of the body;" whence the term "dermoid cysts." It is possible that at the commencement of their formation such cysts may have a general tegumentary lining, a part or the whole of which may afterwards become obliterated. For in the condition in which they generally come under our notice, the tegumentary structure is confined to patches of the lining membrane, while in many the hair is found entirely detached and lying in the form of a loose ball in the centre of a smooth-walled sac.

Sebaceous and Sudoriparous Glands have been shown by Kohlrausch and Heschl to be present in these cysts, where they have the same general arrangement as in the skin (*fig.* 397. *c*).

Fatty Matter. — This occurs under two forms: first, as a loose granular fatty sub-

* Dr. J. H. Bennett on Encysted Tumours of the Ovary and Pelvis, Edin. Med. and Surg. Journ. No. 167.

† Medicin. Biblioth. bd. i. s. 152.

* Anat. Pathol. tom. i. livr. xviii.

† Müller's Archiv. 1843, p. 365.

‡ Traité d'Anat. Pathol.

§ Lectures, vol. ii. p. 83.

stance, of the consistence and aspect of lard or butter, in the midst of which are imbedded those coils of loose hair with which it is usually associated (*fig.* 397. *d*). This fatty material is of a white or yellowish hue, and is commonly inodorous, but sometimes it exhales an intolerably fetid odour, especially in those cases where air has been admitted into the sac, and partial decomposition has taken place, or where fœtid pus has been formed within the cyst. The second condition under which fat is found is that of masses $\frac{1}{2}$—1″ in thickness, lying beneath the general lining of the sac, which is protruded before them, causing irregular elevations into the interior of the cyst (*fig.* 397. *a*). These present the ordinary character of adipose tissue, but possess a smaller proportion than usual of the cellular element.

Hair is found in ovarian cysts also under two forms, either still attached to the walls or lying in loose tangled coils in the centre of the cavity. Those attached to the walls are seen to spring from follicles, which may be scattered evenly over the cyst wall, in which case the hairs are usually short, or they may arise from a group of hair follicles, closely set, and imbedded in a substance clearly possessing the characters of ordinary skin. In the latter case the portions of integument from which they spring are generally elevated upon a mass of subcutaneous fat, as just described, and the hairs, which are well nourished and long, form at their free ends a tangled coil, intermingled with the loose fat already mentioned (*fig.* 397.). In these cases the hair often attains to a considerable length; it is fine and smooth, and resembles the long hair of the back of the head, exceeding sometimes in length two feet. The colour of the hair is usually red, dark brown, or black; it bears no resemblance to the hair of the individual in whom it occurs. Thus, in the case of an ovarian cyst occurring in a negress, Andral observed numerous hairs differing essentially from the woolly hair of the head; they were soft, smooth, red, or blonde, and some were silvery, like the hair of children of white races.

The loose hairs may be easily detached by maceration in turpentine or ether, from the mass of fatty substance in which they are entangled. They are then sometimes seen to be destitute of bulbs. They are usually more crisp and shorter than the attached hairs, except when the latter occur singly.

Teeth are very commonly found associated with hair and fat. These may possess the perfect character of incisor canine or molar teeth, but more frequently the resemblance is only general, and a more accurate examination discovers in them some imperfection of form. The resemblance is sometimes greatest to the deciduous, and sometimes to the permanent set. In the less perfect forms the crowns only are developed, the roots being deficient. But in most cases the intimate texture of the tooth differs in no respect from the ordinary dental structure.*

Ovarian teeth are generally found associated with portions of irregular-shaped bone, in which they are often imbedded. They may, however, be attached to the tegumentary lining of the cyst walls, and more rarely they have been found connected to portions of cartilage.

Bone.—The bones found within ovarian cysts differ from the ossified portions occasionally observed in the cyst in this respect, that, while the latter consist of merely crystalline or amorphous aggregations of earthy matter, the former, although irregular in shape, yet exhibit a true osseous structure, in which may be readily detected the usual arrangement of concentric lamellæ, Haversian canals, lacunæ and canaliculi. Such bones often bear a sufficient resemblance to fragments of jaws and vertebræ to admit of a general comparison with those parts of the skeleton; but well-shaped and perfect bones are not found, except in cysts of whose nature and origin some doubts at least may be entertained.

In *fig.* 397. are represented several of the solid structures commonly found in an ovarian cyst. A long coil of tangled hair, mixed with lardaceous matter, is seen springing from a portion of the cyst wall at a part which is lined by common integument. Here many

Fig. 397

Ovarian cyst containing hair, loose fatty matter, adipose tissue, sebaceous glands, and hair follicles. (After Cruveilhier.)

hair follicles are observed, some being empty, and others containing short hairs. The parts

* This is illustrated by Plate 124. of Professor Owen's "Odontography," exhibiting the microscopic structure of a tooth, from an ovarian cyst in my collection. Five other teeth were contained in this cyst, together with a portion of tegumental structure, subcutaneous fat, bone, and hair.

of the cyst covered by integument are seen to be elevated, and it is in the substance of and beneath such elevations that the fatty tissue and bones are usually found imbedded, whilst the teeth have only their roots concealed, their crowns projecting free above the surface.

Origin of the Solid Contents of Ovarian Cysts.—It has been conjectured that these are examples of the "fœtus in fœtu," or that such remains may be the product of an imperfect ovarian conception. To the former of these suppositions, viz., that such formations result from a cohesion or intus-susception of two or more germs, coincidently impregnated, but of which one only has been perfectly developed, it may be objected that this view fails altogether to explain the circumstance that their formation occurs far more frequently in the ovary than in any other part of the body; nor does it account for the fact that here a particular class of structures only is developed, whilst in the case of penetration of germs one within the other, various portions of a second fœtus, more or less completely formed, and by no means limited to a certain class of structures, are found within the body of the first.

The explanation that these are examples of extra-uterine gestation of the ovarian kind is equally unsatisfactory; for even if the possibility of such a form of gestation be ceded, the fact alone that hair, teeth, and even bones, contained in cysts of the kind under consideration, are never found associated with the smallest trace of the membranes peculiar to the ovum, would be fatal to this view. But it can be shown further that such structures are observed in cases where previous impregnation was highly improbable, as in the examples where they were found in conjunction with a perfect hymen*, or where it was impossible, as in the case related by Dr. Baillie of a girl aged 12, whose generative organs were still undeveloped, but one of whose ovaries was filled with hair, teeth, and fatty matter.

The two additional circumstances that there is scarcely any portion of the body, such as the subcutaneous tissue, the brain, lung, kidney, bladder, and testis, in which similar structures have not been found, and that such formations, though most commonly found in the ovary, are yet not even limited to the female, but have been also observed in the male, completes the catalogue of objections to the argument, in whatever form it may be advanced, that these productions are in any way the offsprings of a spermatic force newly applied to the organisms in which they are formed.

The discovery of the fact that a tegumentary structure forms the basis out of which many of these products spring, appears to carry us a step further towards comprehending the mode in which some at least of the solid contents of ovarian cysts are formed, by exhibiting a connecting link between structures which are elsewhere naturally associated, but it obviously fails to satisfy any inquiry as to the nature or quality of the cell-force which determines the development of such products.

Fœtus, more or less perfect, contained in the Ovary(?)—Ovarian Gestation.—Graviditas Ovaria.—Few facts in physiology have been more readily assumed without sufficient examination than that the fœtus may be developed within the proper structures of the ovary, and so constitute a form of extra-uterine gestation.

So long as it was generally believed that the coitus was the efficient cause of the escape of the ovum from the ovary, and that therefore the act of impregnation preceded that of ovulation, there was nothing in such a belief to challenge inquiry as to the probability of the ovum being first impregnated, and still by some mischance detained within the proper structure of the ovary, where it might become developed. But more accurate views of the nature of ovulation and of the true seat of impregnation have led to a stricter inquiry regarding the seat of supposed ovarian gestation.

Among the earliest to call in question the accepted views upon this subject was M. Velpeau, who, previously a believer in ovarian gestation, laid before the Philomathic Society, in 1825, four examples supposed to be of this kind. An expression of doubts as to the possibility of this fact on the part of many members led to a more perfect dissection of the parts, in which examination MM. Blainville and Serres were appointed to assist. It was ascertained with certainty that three of the tumours were external to the ovary. With the fourth more difficulty was experienced; but at length, after isolating the Fallopian tube, which was sound, the detritus of conception was found to occupy a special sac between the peritoneal and proper coat of the ovary, which was entirely distinct.

In the following year, M. Geoffroy St. Hilares, in a report upon the subject of Breschet's Memoir upon "Interstitial" Extra-Uterine Gestation, expressed his entire disbelief in the ovarian variety, and the same views have been advocated by M. Pouchet in his work on Spontaneous Ovulation, and in this Cyclopædia by Dr. Allen Thomson*, who has there stated the general objections to the doctrine of an ovarian form of gestation.

The cases which appear to favour the belief in ovarian gestation may be divided into two classes, viz., those in which the embryo is yet small, and is contained in a sac of moderate size, which has not yet contracted adhesion with adjacent parts; and those in which the fœtus has attained or approached to full growth, and the sac by which it is surrounded has already contracted adhesions.

All the examples that I have had the opportunity of dissecting, or of seeing examined, have been of the latter class, and of these it may at once be said that nothing can be learned from them which could determine, with any degree of accuracy, so difficult a question as that under consideration.

* Royal Coll. of Surg. Pathol. Collect. prep. No. 2625.

* Vol. ii. p. 456.

The impediments to such determination which recur again and again in these cases are the following. It is easily ascertained that the sac containing the fœtus is external to the cavity of the uterus, and is in some way or other connected with some portion of the internal generative organs; the Fallopian tube, ovary, and broad ligament of one side being chiefly involved in the tumour, while the corresponding parts of the other side may remain free. Dissection may serve to unravel these parts to a certain distance, beyond which nothing satisfactory can be determined, on account of the alteration which the tissues have undergone both in form and arrangement; the hypertrophy of some, and the wasting or blending together of others, rendering further research fruitless for the object in view.

To these impediments, other and still greater difficulties are generally superadded. These arise from the death of the fœtus, which often takes place several months or even years previous to that of the mother. In the decomposition which follows, the harder parts of the contents of the sac fall asunder, and make their way by fistulous openings into surrounding viscera, whose surfaces inflame and give rise to serous and fibrinous effusion, while in the few hours which succeed to the final destruction, the parts decompose so rapidly that the post-mortem examination, however early it may be made, often reveals nothing but a semi-putrid mass perfectly unsuited to the determination of a difficult anatomical question.

For this purpose the cases of the former class can alone suffice. Here the parts are small, and as yet comparatively unchanged, and admitting of dissection. The results of four such examinations have just been given. The following additional examples, which are selected from the best recorded cases supposed to be ovarian, will suffice to exhibit the class of evidence upon which a belief in this species of gestation is demanded.

Cruveilhier* has described and figured a case in which the entire skeleton of a four months' fœtus † is seen hanging external to a sac, occupying the seat of the right ovary, in which it is supposed to have been once contained. The sac said to be in the inner and lower part of the ovary is lined by a serous membrane. The two external thirds of the pouch were filled by a spongy areolar yellowish-white mass presenting all the characters of placental tissue. The outer half of the surface of the ovary was enveloped in a cartilaginous shell. No attempt appears to have been made to trace the entire outline of the ovarian tunics, or to show the condition of the ovarian ligament, or of the Fallopian tube of the same side. The latter, indeed, is not mentioned, but from the representation of the parts it appears to be blended with the cyst, so that this is quite as likely to have been an example of tubal, or ovario-tubal, as of ovarian gestation. The fact also that the cyst had apparently burst and permitted the escape of the fœtus when it had attained the size which is seldom exceeded in tubal cases, lends additional probability to this view.

Dr. Granville * has published a case, accompanied by drawings, which he regards as an "undisputed case of purely ovarian fœtiferous ovum." The uterus is considerably enlarged, but empty. "The left ovarium presented a large swelling which contained within its own covering an ovum bearing a fœtus with all its appendages, of about four months' growth. The ovarian covering burst in three places, and allowed the protrusion of the ovum, whereby the adhesion of the placenta to the inner surface of the ovarian envelope was torn asunder," causing death by hæmorrhage. A blood-vessel, the size of a large crow-quill, which penetrated the dense portion of the tumour, was ascertained to be a branch of the left spermatic artery, and a smaller and much shorter vessel, arising from the tumour, was found to communicate with the spermatic veins. "The corresponding Fallopian tube was perfectly sound and loose, particularly at its fimbriated extremity, which had no connection whatever with the embryoferous tumour in its neighbourhood. Like its fellow tube, it was pervious only from its loose extremity inwards to about half its length. "A placental mass with distinct cotyledonous vesicles connects the child with the inner covering of the ovarian cyst. The secreting or transparent involucra are quite distinct. The *cortex ovi* is almost wholly absorbed, as it ought to be at such an advanced period. The fœtus is perfect." In the explanation of the plates mention is made of "fragments of the corpus luteum which surrounded the ovum, and was broken to pieces by the enlargement of the fœtus. Some of these fragments adhere to the inside of the ovarian coats, others are among the placental cotyledons." No account is given of the ligament of the ovary, nor of such a dissection of the parts having been undertaken as would satisfactorily prove that the sac containing the fœtus was not a cyst attached to the ovary. But the evidence in favour of ovarian gestation consists chiefly in this, that the fœtus-bearing cyst occupied the region of the ovary, and was independent of the Fallopian tube. Nevertheless this case constitutes the nearest approach to the form of gestation which it claims to represent with which I am acquainted.

In the same work (Graphic Illustrations †) is contained a description and representation of a second case termed "ovum fœcundum in receptaculo ovarico." "Through a transversal aperture in the left ovarium are seen the remains of some membranes, three in number at the least, lining a cavity which measures transversely one inch and a quarter, and about an inch vertically." The preparation belonged to Sir C. M. Clarke, who assured Dr. Granville "that a small embryo hung pendulous

* Anat. Pathol. livr. xxxvi. pl. vi.

† Said in the description to be between one and a half and two months, at which time, however, no such complete skeleton is ever seen.

* Phil. Trans. 1820, and Graphic Illustrations of Abortion. Plates X, A, and B.

† P, 27. pl. viii.

from the yet visible rudiment of an umbilical cord. That embryo, however, is not now to be seen." The female from whom this was taken was unmarried, but acknowledged herself to be pregnant. The uterus was larger than in the unimpregnated state. The Fallopian tube was not in the least involved in the enlargement. The fimbriæ were free.

A case which, in the opinion of Dr. Campbell *, "in so far as anatomical accuracy is concerned, ought to satisfy those who are still sceptical regarding the reality of ovarian gestation," is recorded in the Transactions of the College of Physicians.† From the description and drawing which accompanies it the following chief particulars are learned. The uterus, from a woman aged 30 who had committed suicide, was larger than the ungravid organ; its body somewhat globular; its substance, except the cervix, spongy. A decidua nearly ½″ thick, soft, pulpy, and of yellowish-white appearance, lined the interior of the uterine body. The cervix was filled with gelatinous matter, but not sealed up. The vessels of the broad ligament and appendages were remarkably distended; on the posterior part of the left ovary, which was considerably larger than the right, was a round prominence distinct from the general fulness. The tunics of the ovary at this point were numerously furnished with tortuous blood-vessels; and from careful examination it was clear that there had not been any aperture in the external membrane; its surface was perfectly smooth. On dividing the membrane which covered this prominence, a distinct cyst was exposed, which contained an ovum. The internal surface of this cyst was smooth and polished, its external firmly adherent to the substance of the ovary. The ovum was simply in contact with the cyst in two-thirds of its circumference; in the remaining third it was united to it so closely as to be inseparable. The chorion and amnion were perfectly distinct, and by the aid of a magnifying glass, vessels filled with blood were seen ramifying on the former. A yellowish honey-like matter filled the amnion, but the embryo could not be distinguished. Around the ovum for some distance the ovary was loaded with blood effused into its substance.

Except for the statement regarding the decidua there is nothing in this account which would be considered significant of pregnancy at the present time when a more perfect knowledge has been obtained of the various conditions of the ovary in health and disease. Changing the names employed to designate the cysts, this description would apply either to a follicle preparing to burst ‡, or to an incipient stage of cyst formation. To the latter it approximates more nearly. The smooth and polished inner surface of the containing cyst; the union, "so close as to be inseparable," of the cyst termed the ovum by a third of its base to the larger one; the presence of a honey-like matter filling this inner cyst, which is represented in the engraving as not larger than a pea, and the vessels ramifying on the cyst wall, are all conditions commonly observed in early stages of the morbid follicle.

On the other hand, the following are among the conditions which oppose the conclusion, that the ovary was in this case the seat of impregnation, viz., the absence of all trace of an embryo; the so-called chorion, entirely wanting villi, which, in all known cases of the early ovum, more or less cover its surface; the firm adhesion by a third of its circumference, at a time when the ovum naturally lies free and unattached even by any part of its little flocculent villous coat; the impossibility of accounting for chorion-vessels, without an embryo to form them, and still more of explaining how the seminal fluid could reach the ovum through a membrane which is described as "perfectly smooth," and in which, "from careful examination, it was perfectly clear that there had not been any aperture;" the absence of all mention or representation of any of those conditions of the walls of the ripe follicles which in an earlier part of this article have been shown to be always present in the follicle preparing for or soon after rupture, and which must have been present in some degree if this had been a Graafian vesicle containing an impregnated ovum. These together constitute insuperable objections to this case being received as one decisive of impregnation in the ovary, and justify its being regarded rather as an example of cystic formation, which, according to the engraved representation of the parts, it very accurately resembles; notwithstanding that the description of the uterus and decidua would give a strong bias and indeed wish to receive this as a case in which impregnation had obtained, if the state of the parts found in the ovary had corresponded with what is now known to be characteristic of the structures formed in the earliest stages of pregnancy.*

* Memoir on Extra-Uterine Gestation, p. 33.
† Vol. vi. p. 414. 1820.
‡ See *antè*, p. 557.

* I am enabled to add in a note the following particulars relating to two of the four cases quoted above as examples of supposed ovarian gestation, and of which it may be remarked that neither are of recent date, the one having occurred thirty-eight years ago, and the other at least as early — at a time, therefore, when ovarian gestation had not been questioned, and the ovarian ovum in man had not yet been discovered. The preparation, described and figured by Dr. Granville as belonging to the late Sir C. M. Clarke, is now in the possession of Mr. Stone, by whose kindness a more particular examination of it has been permitted. For this purpose, the preparation was recently placed in the hands of Professor Owen, by whom it was removed from the bottle, and minutely examined under spirit. At this investigation, I was also present, together with Mr. Stone and Dr. John Clarke, and I had the opportunity of making repeated microscopic examinations of every portion of the ovarian structures. The result of the investigation showed that the structure supposed to be an impregnated ovum contained in the ovary, although it had such a general appearance as might without this examination have borne the interpretation which had been originally put upon it, was nothing else than an ordinary ova-

It is not necessary to multiply these examples, for no additional points of evidence could be produced which are not contained in the foregoing cases. They have been selected from instances related or quoted by various authors who have been strongest in their advocacy of the doctrine of a strict ovarian gestation, and they serve to exhibit the kind of evidence upon which that doctrine is founded. All the cases which have been employed to support this view* will be found on examination to belong to one or other of the following divisions :—

1. Cases of cysts without any embryo, and in which some supposed resemblance has been traced between the cyst walls and fœtal membranes, without any conclusive evidence of the presence of these structures being given.

2. Cases of dermoid cysts containing fat, hair, teeth, and bones, the nature and origin of which, independent of pregnancy, have been already considered.

3. Cases in which the evidence is more or less complete that a fœtus is or has been contained in a cavity of, or connected with the ovary.

Of the latter, as already stated, those alone suffice for examination in which the cyst has continued unattached to surrounding parts, and has remained unaffected by disintegrating and destructive processes. In this category would still be found, in all probability, a sufficient number of cases amply to have determined the question in dispute, if such methods of investigation had been pursued as the present state of anatomical and physiological science demands for the settlement of doubtful points ; for in a considerable number of cases it is rendered evident that the fœtus is contained within a sac in some way connected with or occupying more or less the usual seat of the ovary. Here, therefore, the question is reduced to very narrow limits, Are these sacs formed within and at the expense of the proper ovarian structures, or are they adventitious cysts growing externally to, although connected with these structures?* If strictly within the ovary, and formed of it or of its parts, then ovarian gestation in the strict sense obtains. But this has not yet been anatomically demonstrated in such a manner as to set all objections at rest; for neither have the blood-vessels been injected in order to ascertain their new relations and distribution, nor have the tissues been microscopically examined, without which examination it would be hardly possible to determine of what parts the fœtus-bearing sac is composed. Nor have the exact limits of the serous and albuginean coats, nor the relations of the sac to the remaining ovarian tissues, nor the precise mode of connection of the fœtal membranes with the sac, been accurately traced. Nor has the condition of the yellow or corpus luteum coat of the follicle, of which brief mention only is made in one instance, been carefully examined ; yet this is a point of the greatest interest and importance, because, if true ovarian gestation ever occurs, then the yellow ovisac would become the *decidua*, and the outer fibrous coat of the follicle, together with the ovarian tunics and stroma, would be the *uterus* of the ovum. But in the present state of our knowledge it cannot be said that the subject of ovarian gestation stands in any other position than that of an open question, the chief points of interest regarding which may be thus stated :—

The unimpregnated ovum is known to quit the ripe Graafian follicle by passing through an aperture spontaneously made in the walls of the follicle and of the ovary, in order to enter the Fallopian tube and uterus, in one of which canals it is afterwards impregnated.

rian cyst. The walls of the sac showed no separation into distinct membranes, and no trace whatever of the structures characteristic of either chorion, chorion-villi, amnion, or decidua could be discovered in them.

The outer surface of the cyst was so firmly adherent to the surrounding ovarian stroma that it could only be separated from it by considerable traction. The connecting medium was the common stroma of the ovary. The walls of the cyst, when portions were examined by transmitted light, exhibited the arrangement of vessels peculiar to ovarian cysts. The little slender depending fragment, supposed to be a rudimental umbilical cord, and very faithfully represented by Dr. Granville in Plate VIII. of the work quoted in the text, proved to be a narrow flap of the same cyst wall which had been left hanging from the edge of the sac where a portion had evidently been originally cut away in order more fully to display the preparation (the sharp edge left here by the knife or scissors being very distinctly seen). Upon transverse section of this little fragment, no trace of umbilical vessels could be found in it.

It should be observed that Sir Charles Clarke never published an account of this case.

The additional particulars which I am enabled to give with regard to the last of the four cases quoted in the text, and described in the Transactions of the Royal College of Physicians for 1820, are of another kind. That this preparation was formerly preserved in the anatomical museum of St. Bartholomew's Hospital, where the author of the case was also the lecturer on anatomy, can scarcely be doubted, from the description, exactly according with it, which appears in the first edition of the Catalogue drawn up by Mr. Stanley. (See Description of the Preparations contained in the Museum of St. Bartholomew's Hospital, 1831. Edited by Edward Stanley, Esq. Preparation 64, series xx. p. 27.) This preparation is no longer contained in the museum ; and by those who are most likely to be informed upon the subject, it is not known to be in existence. The only clue that I can obtain as to its fate is derived from Mr. Paget, who informs me that, as a step preliminary to the formation of the new catalogue, printed in two volumes in 1846-51, the entire anatomical collection was carefully reexamined; and that those preparations which were found, upon such examination, not to bear out the descriptions given of them in the catalogue, or which did not serve to illustrate any point of interest, were put aside and condemned. There is, therefore, every probability that this preparation, which can now no longer be appealed to in support of the possibility of ovarian gestation, has been subjected to a similar ordeal to the former, and with a like result.

* A large collection is contained in the work of Dr. Campbell just cited.

* It is thought by Boehmer that these cases might be divided into external and internal.

It becomes a question whether this law, which has been established by ample testimony, admits of the exception that the ovum may be impregnated before quitting the follicle, and therefore whilst still contained within the ovary.

The records of various cases, in which the fœtus is apparently contained within the ovary, raise this question. For if the fœtus is found strictly contained within structures properly ovarian, then the ovum must have been impregnated within the ovary, and the seminal fluid must have entered the Graafian follicle*, for it cannot be supposed possible that the ovum, having quitted the follicle unimpregnated, should again enter it after being impregnated.

The cases, however, which have been recorded as examples of ovarian gestation do not suffice to demonstrate that the sac containing the embryo or fœtus and its membranes is strictly within the ovary, and is composed of structures strictly ovarian; and until such demonstration has been given, ovarian gestation, in the most liberal view that can be accorded to it, cannot be held to have any other signification than that of the development of the embryo or fœtus in a sac connected with or occupying the usual seat of the ovary, but not yet proved to be developed within the proper structures of that gland.

Origin of Ovarian Cysts in general. — It has been often asserted, and as frequently doubted or denied, that these cysts derive their origin from an unnatural enlargement or dilatation of Graafian follicles. Such a contrariety of views is observable equally with general pathologists, as with those who have studied the special histology of this subject. Of the latter both Rokitansky and Wedl may be considered as still holding uncertain opinions; for Rokitansky, who regards it as probable that the simple cysts are in many cases developed from the follicles, doubts that such is their origin in those instances in which their number far exceeds the usual number of Graafian vesicles, holding them to be new formations; and Wedl says that of the cysts in the parenchyma of the ovary no direct proof has ever been given that they originate in the Graafian follicles; and with respect to those which contain hair and teeth, he regards their origin in this way as "extremely doubtful."

It is obvious that a question of this kind cannot be definitively settled except by minute examination of the morbid cyst in all the early stages of its growth; an examination for which opportunities cannot very frequently arise. The choice lies between the classing of such cysts with those, on the one hand, which originate in the dilatation of natural sacculi and ducts, or with such as have their commencement in the enlarging of areolar spaces, or in the growth of primary cells or nuclei into cysts.

In the case of the ovary, it happens that the settlement of this question is more difficult than in that of most other organs; for with regard to the formation of cysts upon the latter plans, whether the views of Wedl be adopted, that they consist in an excessive augmentation of volume of the areolæ of the areolar tissue, or those of Rokitansky, that a cyst proceeds from an elementary granule which grows, by intus-susception, into a nucleus, and this into a structureless vesicle, in both views such cysts come to be composed ultimately of a cell-wall compounded of fibrous tissue and lined by epithelium — a structure which is, in fact, identical in composition with the Graafian vesicle itself.

With regard to any doubts as to the origin of cysts in Graafian follicles, which may be founded upon their number exceeding the average number of healthy follicles in an ovary, it need only be observed that the latter have been shown by the microscope to be innumerable; and with respect to secondary cysts, springing from the walls of primary ones, numerous observations prove that the impulse to cystic formation once given in an organ, even by the primitive enlargement of normal cavities, a marked tendency to the antogenous formation of cysts follows.* But even if no other explanation could be offered, the discovery of Barry, that the walls of a Graafian follicle in a natural state often contain numerous follicles of a second order, would sufficiently demonstrate the capacity of these for secondary cell-growth.

In giving the preference to that view which regards the cystic diseases of the ovary as originating in a dilatation of the Graafian vesicles, I have been guided chiefly by the following considerations.

In those cases where I have been able to discover cysts in the ovary in a stage of early formation, these have not been of less size than the average dimensions of the developed Graafian follicle.

They occur intermixed with healthy follicles, and exhibit with them the same histological formation; their tissues being altered sometimes only in such slight degrees as still to admit of their common origin with the Graafian follicle being shown.

There is sometimes exhibited in the same ovary, or in the ovaries of both sides together, a sufficient number of grades of enlargement to constitute a series of cysts, evidently composed of similar parts and tissues in various stages of growth.

Beginning with the smaller cysts, still contained in part or entirely within the ovary, there may be traced cysts of precisely similar formation and structure in every gradation of size up to those examples in which the ovary itself comes to be a mere appendage of the

* There is nothing in this supposition incompatible with the known facts relative to the spontaneous opening of the follicle, and the power of penetration of the spermatozoa occasionally as far as the distal extremity of the oviduct, or even to the surface of the ovary.

* Lebert, loc. cit. p. 244.

cyst, or in which the tissues of the healthy organ are entirely expanded and lost in the walls of the sac.

And lastly, the occurrence of these cystic formations is limited to that period of life when the Graafian follicle is in a state of activity. They are not found as new formations after the usual time at which the follicles have ceased to be discoverable in the ovaries as natural structures, nor do they occur before the period of puberty has arrived, except in cases much more rare than those of an unusually early development of these follicles, or of precocious puberty.

These arguments apply more particularly to cysts with fluid contents. How far they may also serve to explain those which contain more highly organised products is less obvious. But it must still be remembered that cystic formations of all kinds occur far more frequently in the ovary than in any other part, whilst there is nothing peculiar in the stroma of the ovary, or that portion which is external to the follicles, which would render it more peculiarly liable to cystic formations arising out of dilated areolar spaces, than similar fibrous structures occurring in other portions of the body where cysts occur.

Solid Enlargements of the Ovary. — These consist of formations of fibrous, and occasionally of imperfect cartilaginous tissues, and of osseous concretions, but more frequently of cancerous growths, formed at the expense of, or deposited within, the tissues of the ovary.

Of formations of *fibrous* tissue some account has been already given in the description of the growth of cysts. The new formations of fibrous tissue which take place in the ovary occur chiefly in the cystic parietes, where they are deposited for the purpose of strengthening the walls and enabling them to resist the increasing weight and pressure of their growing contents. But as fibroid tumours, or solid growths of the entire ovary, such formations, except those of very small size, are certainly rare, unless they are of a cancerous or cancroid nature.

It is probable, indeed, that, excepting the cancerous and cancroid cases, most, if not all, of the specimens which have been described or preserved in museums as examples of *large* fibrous tumours of the ovary, have been formed at the expense of the proper tissue of the uterus, and have had nothing to do originally with the ovary, although the latter may be so involved in the mass that its proper tissues can no longer be distinctly traced.

Such I had no difficulty in determining to be the case with a specimen preserved in King's College Museum as an example of fibrous tumour of both ovaries; each supposed ovary being of the size of an ostrich's egg, and presenting all the characteristics of the ordinary fibrous tumour of the uterus. It was rendered evident, by dissecting the parts and opening the uterus, which had not been done previously, that these large tumours which hung on either side of the uterine body had been formed at the expense of the latter, for the natural tissues of the fundus and corpus uteri were in great part absorbed into and had evidently contributed to form these masses; and out of the apex of one of these sprang the uterine end of the Fallopian tube; a clear proof that this was not an ovary.

In this way may be explained the remark of Cruveilhier, that fibrous tumours of the ovary are so perfectly identical with those found in the uterus, that it is sometimes impossible to determine to which of the organs they have originally belonged; and also the remark of Dr. Baillie, that they resemble in texture the tumours which grow from the outside of the uterus. The absence of the muscular element from the natural tissues of the ovary, and the now well-known fact that the uterine fibrous tumours contain, as one of their characteristic constituents, more or less abundantly the smooth or organic muscular fibre of the uterus, forbid the belief that tumours of similar composition to those found in the uterus can be formed within or at the expense of the proper tissues of the ovary.

Cartilaginous and Osseous Formations, especially the latter, are not rare in the ovary. They are found chiefly in the parietes of cysts, and also intermixed with cancerous deposits. The process of deposition of earthy matter, which should be termed calcification rather than ossification, occurs here under three principal forms.

In fine sections of the more solid structures, or in the thin walls of cysts which are slender enough to be examined without cutting, may be often seen, with a moderate amplifying power, little aggregations of crystals in the form of clavate spicula, clustered round a centre, and forming groups scattered through a fibrous basis. Such tissues are sensibly rough to the finger, and grate under the knife.

In the second form the same calcareous materials, consisting of phosphate and carbonate of lime, combined with a small proportion of animal matter, occur as plates or laminæ, strengthening the walls of cysts; or in the shape of grains, or larger aggregations, or layers intermixed with the tissues of more solid tumours.

In a third form the calcareous matter may constitute an oval or solid mass contained within a small cyst, and resulting apparently from an entire calcification of the inner walls of the cyst.

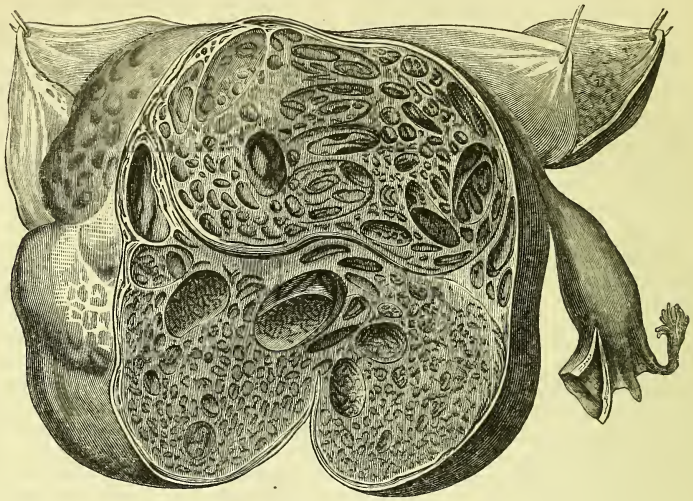
The condition under which true bony structures are found in the ovary has been already considered in another section. (*See* Dermoid Cysts.)

Cancer of the Ovary occurs under the three principal varieties of Colloid, Medullary, and Scirrhous or hard cancer. Most of the large tumours of the ovary, and such of the encysted class as remain still to be described, belong to the variety of

Colloid or Alveolar Cancer, generally associated with Cysts.—These might have been classed,

as has been done by Rokitansky and Lebert*, with the other forms of cystic disease of the ovary, on account of the frequency with which this form of cancer is found associated with ovarian cysts, especially of the larger class. But such an arrangement, whilst recognising an important feature, often, but not always, observed in colloid cancers of the ovary, of necessity dissociates these cases from other congeneric forms of disease. In this particu-

Fig. 398.



Colloid cancer of the ovary. (*After Cruveilhier.*)

lar respect colloid cancer appears to stand between the various cystic diseases already described, and those forms of cancer which are not colloid, in the position of one of those "osculent groups" which have been sometimes employed in classifications of the animal kingdom as connecting links, to bring into juxtaposition objects which, though exhibiting certain near affinities, could not be included in one common group, without violence to the principles upon which a natural arrangement should be based.

Not, however, to enter further upon the disputed question of the nature of alveolar cancer of the ovary, it will suffice to notice those peculiarities which are generally to be observed when the disease affects that organ.

Since colloid cancer of the ovary does not generally destroy life until the disease has made great progress, the specimens of ovaries so affected which come under our notice are often of large size, filling the pelvis and abdomen, and equalling in bulk the masses of cyst formation of a more innocent type. Such a mass, when incised, may be found to include the entire ovarian structure, which is converted into a collection of cysts, or alveolar cavities, varying greatly in size and in the thickness of their walls. Such a variety is often seen in different portions of the same structure. The surface of a section may present in some parts the appearance of a fine sponge, the alveolar spaces being condensed and somewhat flattened, in consequence of the profusion with which the alveoli have been developed. In other portions of the same tumour, and occasionally as it were in separate lobules of it, the alveoli are more expanded, and take a round or oval form, assuming the condition of distinct cysts, some of which may considerably exceed the rest in magnitude. These larger cysts may occupy a seat within the mass, or project from its surface; and probably in this way arise those still larger cystic formations in which one or more large sacs occur, having connected with them masses of alveolar structure such as those just described.

The interstitial substance, which constitutes also the boundary walls of the alveoli and follicles, is composed of a white, shining, fibrous tissue, upon the density of which chiefly depends the general hardness or softness of the mass. This intermediate substance is in some instances so thick that the cysts appear like excavations in a dense medium, but often the cyst walls are so thin that the peripheral follicles project in the form of thin-walled sacs from the surface, and the whole mass is sometimes so feebly supported as to assume the appearance of a trembling jelly. The thin-walled cysts are generally richly supplied with blood-vessels.

These cysts are filled with a viscid mucous-like material, resembling half-liquid jelly, which is sometimes colourless, but oftener of a grayish amber, yellow-green, or reddish hue. Im-

* Rokitansky, however, regards these cases as decidedly cancerous; while Lebert asserts that they have nothing in common with colloid cancer except the gelatinous contents of the cells.

bedded in the jelly-like substance may be found opaque white masses resembling blanc-mange or thick cream. Intermixed with these contents, in varying proportions, are found nucleated epithelial cells, oval corpuscles, oil granules and molecules, and delicate filaments.

Besides these contents of the alveoli, there may be often observed hanging into their interior, and sprouting from their walls, clusters of leaf-like clavate or villous processes, such as are observed in that variety which has more particularly received the name of villous cancer.

But it frequently happens that the alveolar type of structure is not generally diffused through the mass. This may form only a small portion of the diseased ovary, whilst the greater part is composed of one or more large cysts, with contents similar to those just described.

Within such cysts, or growing from the walls of those which present no other type of malignant structure, may be observed round or oval bosses, bearing no inapt resemblance to the uterine cotyledons of the cow, and exhibiting in section the compact areolar texture characteristic of the closer forms of alveolar cancer.

Colloid or alveolar cancer is occasionally found associated with medullary disease in the same ovary, whilst its presence there may be accompanied by other varieties of carcinoma in other organs, and attended by a well-marked constitutional cachexia.

Medullary Cancer of the ovary is of less frequent occurrence than the preceding variety, but like it is also occasionally associated with the formation of cysts.

Medullary cancer may occur either in the form of a general infiltration of the entire ovary with encephaloid matter, or in that of distinct tumours, bounded by a fibrous envelope, and having the carcinomatous matter distributed through an interior cellular substance, or confined there by cellular septa. These tumours may attain the size of an orange or more. Their growth appears to be in the first instance repressed by their fibrous sheaths, but these occasionally burst and allow of the diffusion of their contents. This form of cancer often affects both ovaries together, and is found associated with cancer in other and especially adjacent parts. Notwithstanding the number and variety of the contiguous structures which may be thus involved, the ovary may sometimes be traced as the centre or focus from which the cancerous deposit has spread. This was remarkably the case in an example of medullary cancer, which was for some months under my notice, where the disease commenced apparently in the left ovary, and was found to have spread from this point upwards along the chain of absorbent glands on the corresponding side, as far as the pancreas, and outwardly through the ischiatic notch to the glutæi, and all the adjacent muscles, including in its destructive march the os innominatum, which could be cut with a knife like cartilage. A medullary tumour the size of a walnut was found in the fundus of the uterus, but the rest of that organ, as well as the opposite ovary, had escaped the general destruction.

The *melanoid* variety of medullary cancer is occasionally observed in the ovary. (Roy. Coll. of Surg., No. 2642. and A.) It differs only from the foregoing in having pigment cells, of a black or brown colour, scattered through the carcinomatous matter.

Scirrhous or Hard Cancer and *Cancroid* are by no means so common as the two former varieties. Yet it is not rarely that one meets with the ovary, of one or both sides, in a hard white nodulated condition, resembling somewhat the human kidney, both in size and shape, and having its entire tissue converted into a form of cancroid, characterised by the development of a peculiar kind of stiff close-set fibres, containing between their meshes numerous nuclei (Fibro-nucleated cancroid). Such a condition of the ovary is sometimes found associated with hard cancer in other parts of the body.*

Of *Scrofulous Tubercle* in the ovary I can give no account. Most authors who refer to the subject mention it as rare, but give no decisive instances. Boivin and Dugès, however, have figured an example (*fig.* 16. Atlas) occurring in a girl of 16, associated with tuberculous disease of the mucous membrane of the uterus. In cases of my own, which I had regarded as examples of scrofulous ovary, until submitted to the microscope, I could find no trace of tuberculous matter. By Rokitansky the existence of tubercle in the ovary is altogether denied.

THE PAROVARIUM.

Syn. *Corpus Conicum. Neben-Eierstock. Organ of Rosenmüller.*

These names have been applied at various times to an organ which has hitherto received little attention, but which is nevertheless invariably present in close proximity to the ovary. The first discovery of this body is due to Rosenmüller †, who termed it the corpus conicum. It has since come under the notice of many observers, and particularly of J. Müller. And it has recently been re-examined, and very accurately described by Kobelt ‡, in an essay devoted to this subject, in which the author expresses his surprise that a structure so easily distinguished both by sight and touch, should have attracted comparatively so little attention up to the present time.

The Parovarium is most readily found by holding up the broad ligament between the observer and the light. Within the folds of this membrane, at the part where the layer

* For an example see Roy. Coll. of Surg. prep. 2636.

† Quædam de Ovariis Embryonum et Fœtuum humanorum. Leipsiæ, 1802.

‡ Der Neben-Eierstock des Weibes. Heidelberg. 1847.

of peritoneum, after investing the Fallopian tube, passes off towards the ovary, to form the posterior duplicature which encloses the vessels proceeding to that organ, will be found a small plexus of white tortuous tubes, (*fig.* 403. *a, b, c*) arranged somewhat in the form of a cone whose apex is directed towards the hilum of the ovary *l*, and its base *a c a* towards the Fallopian tube *h*. The entire organ measures about one inch in breadth, and is composed of 12—20 tubules 0·15—0·2‴ in diameter.

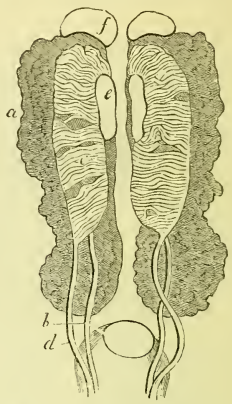
The tubes which contain nothing but a clear fluid consist of fibrous membrane, lined by a single layer of pale, cylindrical, epithelial cells. These tubular canals are not known to have any direct communication with the ovary.

That the parovarium is formed out of the Wolffian body does not now appear to admit of doubt. It has been usually considered that the Wolffian bodies are organs peculiar to fœtal life, and that they afterwards entirely disappear in both sexes. Hence no special investigations have been undertaken with a view to ascertain their ultimate fate. Meckel indeed compared them to the epididymis. Rathke believed that they became epididymis in the male, and disappeared in the female; while Rosenmüller, who discovered the parovarium, compared this body to the epididymis. Some general conjectures also have pointed in the male sex to the *vascula aberrantia* of the epididymis, and in the female to the organ of Rosenmüller and the ducts of Gärtner, as the supposed remains of the Wolffian body. Nevertheless it is, according to Kobelt, an undoubted anatomical fact that each pretended ephemeral structure not only exists through the whole of life in both sexes, but that it absolutely increases up to its highest state of perfection, and first suffers a gradual retrogression, after the extinction of the reproductive function, but never entirely disappears.

The signification and true homologies of this singular organ cannot be understood without first briefly examining the mode of formation and development of the Wolffian body, and tracing its relation to the generative gland and Fallopian tube. In this examination it is also of consequence to compare the progressive steps of formation of those parts with the corresponding structures in the male.

The Wolffian body is most readily examined in the chick, (*figs.* 399, 400.) Here during the third day of incubation are formed two canals which extend along the sides of the vertebral column, from the heart to the posterior extremity of the body. To the inner side of each canal is attached a series of blind pouches (*fig.* 399. *c* and 400. *b*), which during the next two days become lengthened and convoluted. These together constitute the Wolffian body. Behind them, and formed independently at a somewhat later period, lie the kidneys (*fig.* 399. and 400. *a*) and supra-renal bodies, (*fig.* 399. *f*, 400. *d*) and as these increase, the Wolffian bodies diminish. The testes (*fig.* 399. *e*) and ovaria (*fig.* 400. *c*) are developed upon the inner border, and in front of the corpora Wolffiana.

Fig. 399.

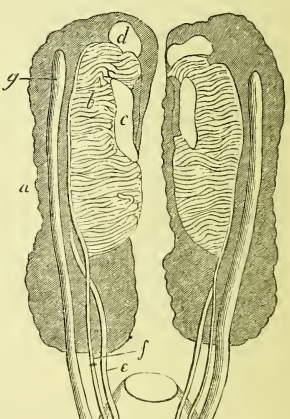


Kidneys, Wolffian bodies, and testes of an embryo bird. Magnified. (*After Müller.*)

a, kidney; *b*, ureter; *c*, Wolffian body; *d*, excretory duct of the latter, which, according to the views of Müller and Kobelt, afterwards becomes the vas deferens; *e*, generative gland, afterwards becoming testes; *f*, supra-renal capsules.

In the female chick, according to Müller, there is always seen an oviduct (*fig.* 400. *g*),

Fig. 400.



Kidneys, Wolffian bodies, ovaries, and oviducts of a fœtal bird, at a period when both oviducts are still of nearly equal size. Magnified. (*After Müller.*)

a, kidney; *b*, Wolffian body, *c*, ovary, the right * rather the smaller; *d*, supra-renal capsule; *f*, excretory duct of the Wolffian body, which in the female becomes obliterated, but in the male is converted into vas deferens; *g*, duct of Müller, afterwards oviduct or Fallopian tube.

* The drawing has been reversed in engraving. The left, therefore, should be here the right side.

distinct from the duct of the Wolffian body (*fig.* 400. *f*). In the male, however, he has been able to detect no vas deferens distinct from the excretory duct of the corpus Wolffianum; but on the contrary, the testis and the excretory duct of the former body seem to become connected by means of vasa efferentia. This is an important point, because it will be found so far to bear out the views of Kobelt regarding the homologies of these structures.

In the mammalia generally, and in man, the Wolffian bodies are less extended. They, however, possess the same arrangement of transverse cæcal tubes (*fig.* 401. *a—d*), terminating in the side of a common excretory duct (*e*), which leads from the lower extremity of the organ to the uro-genital sinus.

These structures are all formed independently of the kidneys and supra-renal capsules, as well as of the ovaria and testes, which parts occupy the same relative position in mammalia as in birds.

But here, according to Müller's researches, a different arrangement is observed in regard to the efferent duct of the generative portion of these structures. At first the oviduct and the vas deferens have each the same conformation, and each terminates by a free extremity. This, in the female, merely acquires an open mouth, and thus the Fallopian tube is formed, the ovary continuing, as at first, distinct and separate. But in the male the efferent tube and the testis become connected by transverse vessels, which are afterwards converted into the coni vasculosi of the epididymis, whilst the rest of that organ is composed of the convolutions of the efferent tube itself. "The Wolffian bodies entirely disappear in both sexes, and are not converted into any other organ." *

These views, however, leave unexplained many peculiarities which are observable in the permanent condition of the parts or organs developed from the fœtal structures; and it is the great merit of Kobelt's researches that they serve to render these intelligible.

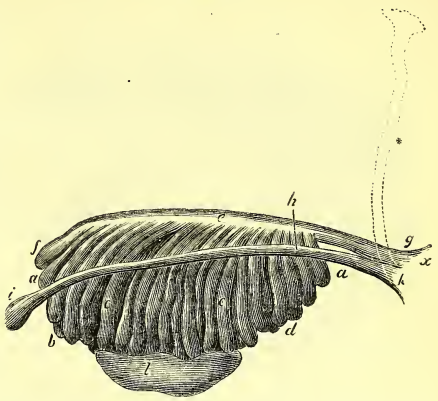
According to this observer, there exists, in the earliest periods of intra-uterine life, a condition of indistinction of sex in every individual. This depends upon a temporary co-existence in each individual of all the elements of the reproductive structures. For at the highest point of sexual indifference, that is, shortly before the beginning of the division of sex, the Wolffian bodies consist of —

1. The so-called cæcal tubes (*fig.* 401. *a—d*).

2. Of the common duct (*e*) running along the outer side of this body, into which the cæcal tubes open.

3. And of a second longer cord (*h*), which begins in a blind pouch (*i*), and takes its course inwards over the Wolffian body, parallel with the excretory duct of the latter (*e*), in order to enter the uro-genital canal (*x*), by a separate orifice (*k*). This last cord, discovered by John Müller, is throughout destitute of any connection with the cæcal pouches. (See also *fig.* 400. *g*.)

Fig. 401.



The left Wolffian body at the period of indistinction of sex. (*After Kobelt.*)

a a, entire collection of its component tubules divisible into three sets, viz., *b*, upper; *c*, middle; *d*, lower set; *e*, excretory duct of the Wolffian body into which all the tubules open, subsequently converted into vas deferens in the male, and becoming atrophied in the female; *f*, terminal bulb of the same, becoming afterwards the so-called hydatid, often seen attached, in the male, to the head of the epididymis (*fig.* 402. *f*), and in the female to the broad ligament (*fig.* 403. *f* and 408. *g*); *g*, opening of the Wolffian body into *x*, the uro-genital canal; *h*, duct of Müller, afterwards Fallopian tube in the female, and becoming atrophied in the male; *i*, terminal bulb of the same, becoming the hydatid of Morgagni (*fig.* 402. *i*) in the male, and the hydatid often seen depending from the mouth of the Fallopian tube in the female (*Fig.* 403. *i* and 368. *ee*); *k*, junction of the duct of Müller with the uro-genital canal; * shows the subsequent horizontal position of this duct when it has become Fallopian tube.

The organ destined for the preparation of the reproductive material, the generative gland, (*fig.* 401. *l*), consists of a longish, clearly defined structure, lying upon the inner side of the Wolffian body, so as to cover a portion of the bulbs of the cæcal pouches. Its white colour serves to distinguish it, at a glance, from the yellowish brown Wolffian body. As yet, no material nor actual distinction of sex can be discovered in any one of these parts; and yet the whole already contains all the elements of the male, as well as of the female, reproductive apparatus, without any true exhibition of bi-sexuality.

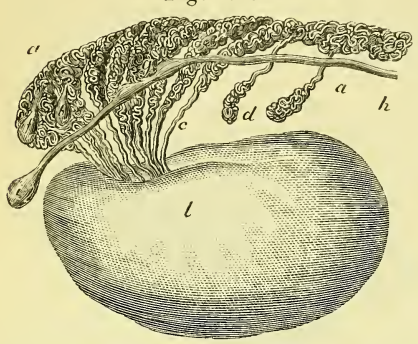
The nature of the first impulse towards a division of sex, in one or other direction, is unknown, but the subsequent separation manifests itself with the commencing distinctive development, and correlative retrogression of each several element; for the cardinal organ, the generative gland (*fig.* 401. *l*), may be converted into testis (*fig.* 402. *l*), or ovary (*fig.* 403. *l*), and through the doubly existing excretory duct of this gland, viz. the duct of Müller (*fig.* 401. *h*), for the female, and the

* Müller's Physiology, by Baly, p. 1637.

excretory duct of the Wolffian body (*fig.* 401, *e*) for the male, the capability of conversion into either sex exists at this time in every individual.

The division of sex begins to be anatomically discoverable by the development of one, and the stationary condition or disappearance of the other of these ducts. From this point, therefore, the course which each of these organs takes, is different for either sex. The male Wolffian body never disappears in all its parts, but is converted into the epididymis in such a manner that the middle line of cæcal tubes (*fig.* 401. *c c*) is transformed into the 18—20 coni vasculosi (*fig.* 402. *c*); while their straight and open ends, as vasa efferentia, establish a communication with the rete vasculosum testis. The upper blind pouches (*fig.* 401. *a, b*) and the bulb (*f*) of the excretory duct disappear, or become converted into the hydatids (*fig.* 402. *b, f*) upon the head of the epididymis, while the inferior pouches (*fig.* 401. *d*) disappear in part, and in part become elongated and tortuous, without forming any connection with the testis. These constitute the hitherto enigmatical vasa aberrantia of Haller (*fig.* 402. *d*).

Fig. 402.



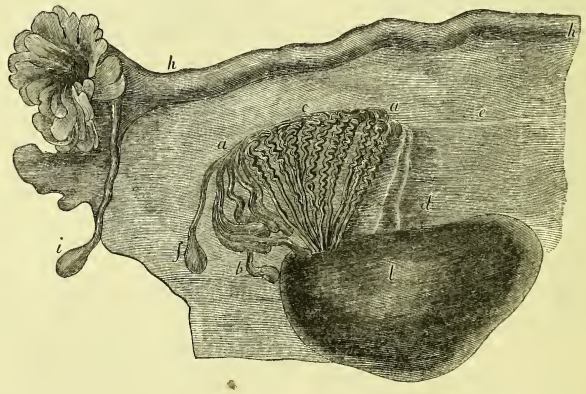
Adult testis and epididymis, anterior view. (*After Kobelt.*)

a a, entire series of metamorphosed tubules of the original Wolffian body; *b*, remains of the upper set, converted into the hydatid in the head of the epididymis; *c*, the middle set converted into the coni vasculosi; *d*, the lower set converted into the vasa aberrantia; *e*, excretory duct of the Wolffian body, now the canal of the epididymis and vas deferens; *f*, bulb of the same, now a so-called hydatid; *h*, duct of Müller, not destined to be developed in the male; *i*, terminal bulb of the same, now the hydatid of Morgagni; *g*, hydatiform swellings of the same in the border of the epididymis; *l*, generative gland, now testis.

The excretory duct of the Wolffian body (*fig.* 401. *e*) is converted into the canal of the epididymis, (*fig.* 402. *e*), and ultimately into the vas deferens, and whilst the retrogression and final obliteration of the terminal part of this duct takes place normally in the female, (*fig.* 403. *e*) it constitutes a pathological condition when it occurs in the male. The terminal bulb (*fig.* 401. *i*) of the duct of Müller is converted into the hydatid of Morgagni (*fig.* 402. *i*), whilst its inferior portion (*fig.* 401. *h*) still exists, at a later period in the anterior border of the epididymis (*fig.* 402. *h*).

Tracing the development of the corresponding structures from the same point of departure as in the male, we find that in the female, also, the Wolffian body never disappears entirely, but is employed in the formation of the parovarium. Its middle blind

Fig. 403.



Adult parovarium, ovary, and Fallopian tube. (*After Kobelt.*)

a a, entire series of tubules of the original Wolffian body; *b*, remains of the upper set, which occasionally become distended by collections of fluid, and constitute one form of dropsy of the broad ligament; *c*, middle set of tubules forming the principal part of the parovarium; *d*, lower set atrophied, answering to the vasa aberrantia in the male; *e*, atrophied remains of the excretory duct of the Wolffian body; *f*, terminal bulb of the same, converted here into the hydatid often seen attached to the broad ligament; *h*, the former duct of Müller, now Fallopian tube, with its infundibulum, from which hangs *i*, the terminal bulb, now converted into a pedunculated hydatid; *l*, generative gland, now the ovary.

These three last figures are from Kobelt, whose views they illustrate. The letters refer to corresponding parts in each.

pouches (*fig.* 401. *c c*), are converted into the 18—20 tubules of the parovarium (*fig.* 403. *c*), and these secerning tubes become organically connected with the hilum of the ovary, *l*. They are the homotypes of the male coni vasculosi, and vasa efferentia, but which constitute here vasa adferentia.

The superior blind pouches and the bulb of the excretory duct disappear, or contribute to form the hydatids at the outer border of the parovarium (*fig.* 403. *f b*), which are so commonly mistaken for morbid structures.

The inferior blind pouches (*fig.* 401. *d*) remain and represent the vasa aberrantia of Haller (*fig.* 402. *d*), in the male. Several of them become elongated and intermingled with the vessels of the spermatic plexus (*fig.* 403. *d*).

The excretory duct of the Wolffian body (*fig.* 401. *e*) in the female, undergoes a retrogression in its whole length, and the lower end disappears entirely. (*Fig.* 403. *e*).

The duct of Müller (*fig.* 401, *h*) is converted into the Fallopian tube (*fig.* 403. *h*), and its bulb (*fig.* 401. *i*) becomes the terminal hydatid of the same (*fig.* 403. *i*). This latter structure, of which a very excellent example, as occurring on both sides, is given in *fig.* 368. *e e*, is very constantly present in the adult. Like the so-called hydatid (*fig.* 403. *f* and 408. *g*) at the outer border of the parovarium, it is frequently mistaken for a morbid product, and is often so designated in descriptions of these parts ; an error which the improper title of hydatid tends to propagate.

The interruption or deficiency of the Fallopian tube in the female is a malformation, which represents a normal condition in the male.

The parovarium exhibits parallel stages of development and retrogression with its corresponding ovary at different periods of life.

Abnormal Anatomy of the Parovarium. — So little attention has been given to this structure in its natural condition that accurate information regarding its morbid states can hardly be looked for. The so-called hydatids, which are found at the outer border of the parovarium in most adult specimens, and which are constructed out of the superior blind pouches and bulb of the excretory duct of the Wolffian body, have been already just noticed as normal structures. These are found pretty constantly in younger subjects, while the hydatids of later formation in the alæ vespertilionum are formed of the remains of the canals of the retrograde parovarium. Within the walls of these canals is collected occasionally a considerable amount of fluid, and it is probable that this is the origin of those larger accumulations to which the term dropsy of the broad ligament has been applied.

FALLOPIAN TUBE OR OVIDUCT.

Normal Anatomy.

Tubæ uteri vel Fallopianæ ; oviducti ; vasa spermatica vel ejaculantia, Lat. ; *Muttertrompeten*, Germ. ; *Trompes utérines, Trompes de Fallope*, Fr.

The Fallopian tube (*fig.* 368. *c c*, and 404. *a b c*) is the excretory duct of the ovary, as its homotype, the vas deferens, is the excretory conduit of the testis. And while in an anatomical point of view the tube is an appendage of the uterus, in a physiological sense it must be regarded as the proper appurtenance of the ovary. But the Fallopian tube differs from the vas deferens, as well as from every other excretory duct in the animal economy, in this important particular, that it is entirely detached from its proper gland, between which and the uterus it serves to establish only a temporary communication.

This separation of the oviduct from the ovary is associated with a higher type of general structure than that which accompanies the blending of these parts. It is first observed in the cartilaginous fishes, and prevails in all classes of the animal kingdom above them ; while in the osseous fishes and in the invertebrata possessing distinct ovaries, the oviducts are directly continuous with those bodies.

The Fallopian tube or oviduct is developed equally on both sides of the body in all vertebrate animals, except in the class Aves, where the right tube becomes atrophied at an early period, while the left alone is developed.

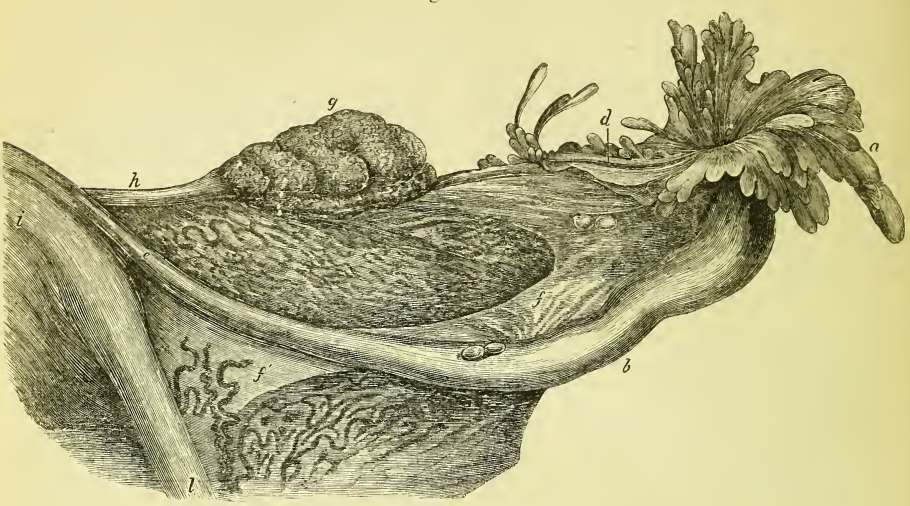
In the human subject each ovary is provided with its proper oviduct, which serves to convey the ova from either side to the central organ, the uterus. But the detached position of the oviduct permits so great a range of motion in its free extremity, that, not only can this be applied to every part of the surface of the corresponding ovary, but the tube of one side may occasionally serve as a conduit to the opposite gland, and receive its product. The action of the tube, however, is then imperfect ; and, when impregnation obtains, an abnormal form of gestation usually results.

Form and dimensions. — Each oviduct has the form of a conical tube, the base of which is free and directed towards the ovary, while its apex is attached to the corresponding superior angle of the uterus, out of which it appears to arise.

The form of the tube was compared by Fallopius to that of a horn or trumpet, which instrument, when straightened or only slightly curved, it sufficiently resembles. Issuing from the upper angle of the uterus, at the point of junction of the superior and lateral borders, the oviduct commences round and narrow (*fig.* 404. *c*), and proceeds outwardly gradually and regularly widening up to its distal extremity, where it contracts somewhat

suddenly just before terminating in a widely expanded funnel-shaped orifice. In the latter half of its course the tube exhibits certain flexuosities, which produce an appearance of contraction at intervals. But that no such contractions really exist is rendered evident by

Fig. 404.



Left Fallopian tube from an adult. (*After Richard.*)

a, pavilion and fimbriæ; *b*, body of the tube; *c*, abdominal orifice; *d*, tubo-ovarian ligament and fringes; *e*, commencement of the tube; *f f*, tubal mesentery; *g*, ovary; *h*, ligament of the ovary; *i*, uterus; *l*, round ligament.

distending the tube with air or water; a process which invariably removes this appearance, and serves to demonstrate the uniform and equable enlargement of the canal.

The length of the tube varies in different subjects, and to a slight extent on the two sides of the same subject. But this difference is not nearly so marked as that often observed between the respective distances of the two ovaries from the uterus. The ordinary range of length of the tube, measured between its extreme points and disregarding the flexuosities, is $3\frac{1}{2}$—$4\frac{1}{2}''$; but the curvature and flexuosities add usually 1—$1\frac{1}{2}''$ to this length.

The breadth of the tube is considerably greater at the distal than at the proximal end. Just at the point of emergence from the uterine border, where the tube is firm and cord-like (*fig.* 404. *e*), its external diameter is $1\frac{1}{2}$—$2'''$. From this point it gradually increases in breadth, and becomes softer, so as to assume the general appearance of an intestine. The mean diameter of the tube is found at about three-fifths of its length (*b*) from the uterine end, where it measures $2\frac{1}{2}'''$; from this point the enlargement is more rapid, until the greatest diameter is attained just before the terminal contraction occurs, and here the transverse measurement is $5'''$.

Situation and connections. — Of the three structures termed appendages which arise in a triangular form from the superior angle of the uterus, the Fallopian tube occupies the apex of the triangle, while, at nearly equal distances from it are inserted the ligament of the ovary, and the round ligament; the former posteriorly, and the latter anteriorly. In the natural position of the parts, the tube, viewed from without, appears to spring from the uterine angle with a slight downward curve (*fig.* 404. *e*), and then inclining horizontally forwards and outwards, it describes an irregular semicircle, whose inner side looks backwards towards the ovary (*g*), which is placed nearly opposite to the centre of its length (*figs.* 368. and 404.). Such at least are the relative situations which these parts exhibit when spread out equidistantly from each other: although it is probable that during life they are more collapsed and lie closer together, — the anterior wall of the tube then being in apposition with the sides and back of the bladder, while its posterior wall corresponds, at its centre, with the ovary, the superior border with the small intestine, and the inferior with the fold of peritoneum by which the tube is attached to the broad ligament. The mouth or abdominal end of the tube is generally directed inwards and backwards, towards the distal extremity of the ovary, in close proximity to which it is preserved by means of the tubo-ovarian ligament (*figs.* 368. *n* and 404. *d*).

The fold of peritoneum (*fig.* 404. *f*), which connects the tube with the main portion of the broad ligament resembles a mesentery and serves to convey blood-vessels and nerves, as well as to sustain the tube in its place, and to limit its movements. It constitutes that portion of the broad ligament

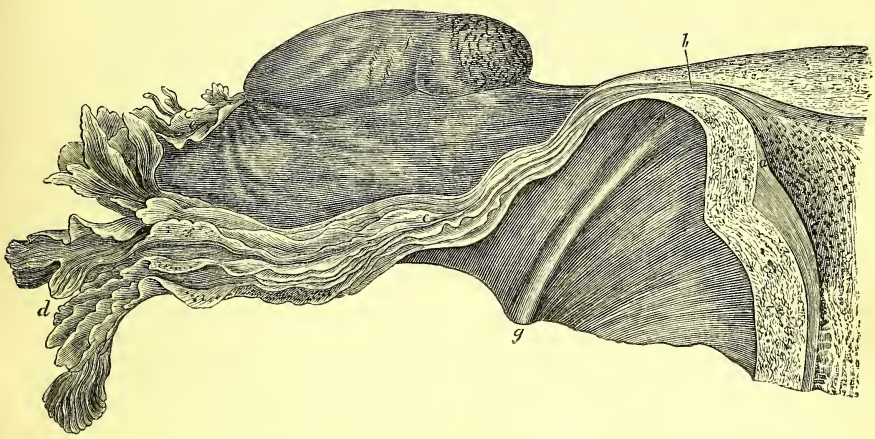
termed the middle wing. The Fallopian tube occupies the entire upper border of this wing, and receives from it a complete peritoneal investment, except along the lower border or line of junction of the two surfaces of membrane composing it, at which line the vessels and nerves enter. Thus the tube resembles an intestine in the mode of its investment, but with this difference, that the peritoneal coat is more loosely applied, especially in young subjects; where the convolutions of the tube are more distinctly marked, and lie free within the sheath, which does not follow their windings (*fig.* 418.).*

The tubal mesentery (*fig.* 404. *f*) is triangular, or somewhat falciform in shape. Its narrow pointed end is directed towards the uterus, where the tube has scarcely any capacity for independent motion; but as the depth of the mesentery increases outwardly greater freedom of movement is permitted. The greatest breadth of the mesentery is found at a distance of two thirds of its length from the uterine extremity, and here it measures $1\frac{1}{2}''$. From this point a slight narrowing occurs, and the membrane terminates in an abrupt margin $1\frac{1}{4}''$ in length, which extends from the lower border of the mouth of the tube to the bulbous extremity of the ovary.

This border, which is thickened by the addition of a layer of mucous membrane derived from the mouth of the Fallopian tube, constitutes the tubo-ovarian ligament (*fig.* 404. *d*).

Separate parts and divisions. — The full extent of the Fallopian tube cannot be ascertained until the entire canal, in its interior, has been laid open. The tube which, externally viewed, appears to spring from the

Fig. 405.



Right Fallopian tube laid open. From an adult who had not borne children. (*After Richard.*)

a, funnel-shaped canal leading from the uterus to *b*, uterine portion of the tube; *c*, point at which the large plicæ commence; *d*, infundibulum covered by plicæ, continuous with those lining the canal; *e*, tubo-ovarian ligament and fringes; *f*, ovary; *g*, round ligament.

superior angle of the uterus, is thus seen to commence by a small orifice, *ostium uterinum*, upon the inner surface of the uterus. This orifice conducts to a narrow canal (*figs.* 405. *b* and 406.) which, after traversing the walls of the organ, and constituting the *pars uterina*, expands into a gradually widening tube (*fig.* 405. *c*), whose form nearly corresponds with the external configuration of the part. Towards the extremity of this canal, a sudden contraction occurs, constituting the external orifice of the tube, *ostium abdominale* (*fig.* 404. *c*). But this does not form the termination of the oviduct, for the latter immediately widens into the trumpet-like orifice (*infundibulum*), whose margin, split up into numerous fringed processes, (*fimbriæ*), (*fig.* 404. *a a*) give to that part the torn and jagged appearance suggestive of the idea that it has been bitten or torn, as expressed in the name, *morsus diaboli*, applied by ancient writers to this part. Each of these parts exhibit peculiarities of structure, requiring a special description.

Internal, or uterine orifice, ostium uterinum. — This orifice, which ought to be regarded as marking the termination rather than the commencement of the tube, is found at the extremity of a short, funnel-shaped conduit, (*fig.* 405. *a*) which leads from the general cavity of the uterus into the upper and outer angle on either side of that organ. Here, while there is no abrupt line of demarcation to indicate the point of commencement of the canal, the characteristic structure of the uterine mucous membrane gradually ceases. The peculiar arrangement of its capillary vessels and the orifices of the uterine glands,

* For a further account of the reflections of peritoneum, which enclose the uterine appendages see "Ligaments of the Uterus," in this article.

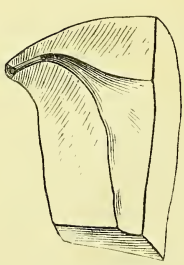
can no longer be discerned, and a slightly plaited condition of the lining membrane of the canal begins to be distinguishable (*fig.* 405. *b*).

At this precise point is found the true uterine orifice of the canal, the diameter of which varies in different subjects, but is rarely of larger size than suffices for the easy passage of a common bristle. The true diameter of the tubal cavity at this point is best exhibited by a transverse section; for when the canal is laid open longitudinally, and its walls are separated as at *b*, in *fig.* 405. this portion of the interior of the tube appears to have a greater diameter than it actually possesses when the parts are closed, and in a natural state. In some subjects, however, and in certain conditions of the tube, the uterine orifice may be sufficiently patulous to admit of the passage of a fine probe.

Uterine portion of the tube, pars uterina. — This, as just stated, is the portion of the oviduct which traverses and is included in the substance of the uterine walls. Its length will vary, in some degree, with the varying thickness of those walls, in different subjects; yet not entirely so, because this canal does not pierce the uterine parietes in a direction perpendicular to their surface, but traverses them in an oblique manner, while the tissues become gradually attenuated around it, in a direction from within outwards (*fig.* 405. *b*).

But the course of the tube through the uterine walls may be still more satisfactorily traced by the aid of a section made down to, but not laying open, the canal. The peculiar white colour of the tube is thus made to contrast strongly with the surrounding darker uterine tissue; and this peculiarity is rendered more striking when a fine injection of the part has been made. The canal of the tube may thus be readily traced from its infundibular-shaped commencement running, in the first half of its course, in a direction obliquely upwards and outwards, and in its remaining half, either horizontally outwards,

Fig. 406.



Entrance of the Fallopian tube into the uterine cavity, dissected down to the mucous membrane, which is left unopened. (*Ad Nat.*)

or more commonly turning rather suddenly downwards, and forming, with its first direction, an angle of 60° (*fig.* 406. and 431.).

Strictly, the Fallopian tube should be deemed to commence at this point; and this should be regarded as the true *ostium uterinum*, while the short infundibular canal leading to it from the uterine cavity should be considered a portion of that cavity, representing, in fact, the cornu of the uterus in mammalia. The peculiar form of this portion of the tube is not without interest, for it appears to me to offer a probable explanation of the occasional detention of the impregnated ovum, in its passage through this division of the oviduct, where its development produces the variety of extra-uterine pregnancy termed by Breschet interstitial.

Canal of the body of the tube. — While the portion of the Fallopian tube already described, as contained within the substance of uterine walls, is rightly termed its uterine or fixed portion, the main part, which is external to them, constitutes the free portion. This also is traversed in its entire length by a canal, the form of which corresponds generally with that of the tube itself. It is occupied by numerous longitudinal folds of the lining membrane (*fig.* 405. *c*), which are so closely placed as to convert the channel of the tube into a series of minute capillary canals. These folds never disappear by distension like the folds and furrows upon many mucous surfaces, such as the œsophagus, bladder, &c.; but they are true plications, like the valvulæ conniventes of the small intestine, as pointed out by M. Richard, who has very accurately described their arrangement.* Each of these is composed of two layers of mucous membrane united together by cellular tissue. Their direction is constantly parallel with the axis of the tube. In the uterine region of the oviduct, they constitute two or three small projecting and rigid crests, forming the little capillary channels, but in proportion as they advance towards the outer part, they become more elevated and numerous, and at 2 or 3 fingers' breadth from the uterus commence the large floating folds which are prolonged as far as the pavilion. These floating plaits are from 4 to 6 in number; they acquire a breadth of 2—3‴, and are themselves covered by an infinite number of little crests, often imbricated the one upon the other, and intercepting between them little capillary canals. On a level with the abdominal opening these large folds cease, the small ones only remaining; but still one of these large folds always extends beyond the orifice.

External orifice, ostium abdominale. — This occupies the bottom of the funnel-shaped expansion or trumpet-like end of the oviduct, and is formed simply by a constriction of the tubal walls at a short distance from the irregularly notched margin in which they terminate. The aperture is fringed in its entire circumference by the plications of the membrane already described (*fig.* 405.). These radiating towards the centre appear nearly to obstruct the entrance of the tube,

* Thèse, p. 35.

which, however, during the middle period of life is usually of sufficient capacity to admit easily of the introduction of a moderate-sized catheter. The constriction which forms this aperture is not occasioned by any thickening nor other alteration of texture in the walls of the tube, so that after the parts have been laid open, it is often difficult to determine the exact seat of the previously existing orifice by any mark except that of a slight diminution in breadth of the walls at this spot.

The Pavilion, or Infundibulum consists of the expanded or trumpet-mouthed portion of the tube which lies between the orifice just described and the fringed margin in which the tube-walls actually terminate. No portion of the Fallopian tube is so variable in form and construction as this, and yet none is of such importance, for upon the peculiar construction of this part depends the special action of the oviduct in grasping the surface of the ovary, and receiving and conveying away the ovum.

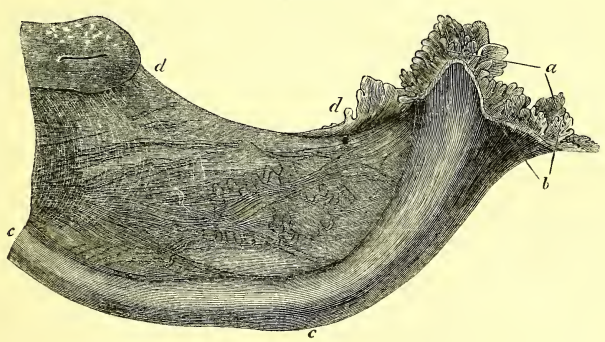
The representations which in illustrated works usually accompany the description of this part serve to give but a feeble notion of the beauty of its construction, apparently because the advice of De Graaf, that their structure should be examined under water, has been commonly neglected. But without the support derived from a fluid of greater density than the atmosphere, the extremely delicate plicæ and fringes with which the expanded mouthpiece of the tube is beset, collapse and exhibit nothing more than a general indication or outline of their true form.

When thus examined, the pavilion in young and healthy subjects is observed to be funnel-shaped, and to have arranged upon its inner surface numerous folds and leaflets, which are merely continuations of the larger and smaller plicæ lining the cavity of the tube. These folds, which are irregularly though often very closely set, converge towards the centre of the orifice of the tube, and in some cases appear by their profusion almost to block up the entrance of the canal. The office of these folds is doubtless to receive and entangle the delicate ovum in one of the numerous channels which are formed between the sets of leaflets, and so to conduct it infallibly into the common orifice towards which they all converge.

So great is the variety perceptible in the conformation of this structure in different subjects, that it would be difficult to find any two in which a precisely similar arrangement of parts obtained. Even in the same body there is often a material difference in the pavilion of the two sides. And these varieties are not attributable to mere individual peculiarities of form, but they appear to bear a certain relation to the age of the person in whom they are found*, and consequently to the period of functional activity or otherwise of the structures of which they form an important part. Thus in young subjects, after the age of puberty, and in those who have borne few children, the pavilion exhibits that richness and profusion of folds and fringes which is represented in *figs.* 404. and 419. while in multiparæ and those advanced in life a greater simplicity of form in this part is commonly observed; but between these extremes every variety of arrangement may be observed.

In the fœtus, and in very young subjects, the margin of the pavilion is nearly evenly circular. This form is also seen in adults in those rare cases where the prolongation of one of the fimbriæ along the tubo-ovarian

Fig. 407.



Portion of Fallopian tube from an adult. (*After Richard.*)

a, external surface of the fimbriæ; *b*, line of demarcation between the mucous and serous membranes; *c c*, body of the tube; *d d*, tubo-ovarian ligament, presenting scarcely any trace of the fringes.

ligament does not occur, but commonly the margin is uneven or scolloped, as shown in *fig.* 407.

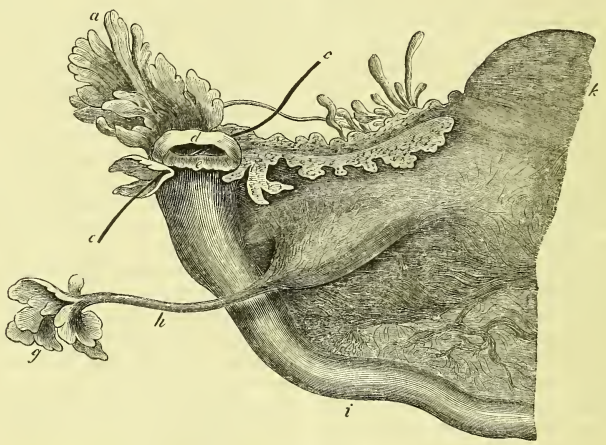
At this point, the opportunity occurs of examining an arrange ment of parts which is unique in the animal economy, viz., the conjunction of a serous with a mucous membrane. The line of junction of these two

* Richard, Thèse, Anatomie des Trompes de l'Utérus chez la Femme. 1851.

surfaces may here be traced along the margin where the tube wall terminates. Here the peritoneal or outer covering of the tube may be observed to cease suddenly in the form of a distinct boundary line, as in the example represented in *fig.* 407. But occasionally the peritoneal coat is prolonged upon the base of the principal leaflets which crest the end of the canal, and in that case a closer examination is necessary in order to discover the line of union between the mucous and the serous surfaces.

The fimbriæ, laciniæ (λακίς), *or morsus diaboli.* —The structure and composition of these appendages differ in no respect from those of the plicæ or folds of which they are merely continuations. These fimbriæ present many varieties of form, but are generally either petiolate, lanceolate, or simply filiform. Their margins are in some cases coarsely crenate, like those of the tubal plicæ, while in other instances they are so finely indented, as to require the use of a lens for their examination. The greater number of these fimbriæ are attached to the sides or margins of the infundibulum by their narrower extremity only, like leaves thickly clustered on the branches of a tree, while the more obtuse extremity of each leaflet is left free, apparently with the object of increasing the extent of surface of the tube-mouth, which may be applied to the superficies of the ovary. But very commonly one or two fimbriæ are observed to be firmly attached by both ends, while the body extends horizontally in the form of a flattened band among the rest of the fringes, as at *fig.* 408. *d.* The backs of these are always covered by a continuation

Fig. 408.



Abdominal end of right Fallopian tube, from an adult. (*After Richard.*)

a, fimbriæ irregularly formed; *c c*, bristle passed through an accessory pavilion; *d*, horizontal band across the mouth of the tube formed by one of the fimbriæ having both ends fixed; *g h*, peduncle ending in fringed processes, probably the terminal portion of the Wolffian duct. (See *fig.* 401. *f*, and explanation.) *i*, body of Fallopian tube; *k*, ovary. The tubo-ovarian ligament and fringes are well developed in this specimen.

of the serous membrane. It is difficult to imagine a use for them unless they are placed there as a safeguard to diminish the risk of a retrograde movement and escape of the ovum after it has entered the tube along one of the furrows formed between the plicæ.

The length of the fimbriæ ranges from $\frac{1}{2}'''$ to $\frac{3}{4}''$. The principal leaflets, being continuations of the 4 — 6 main plicæ of the tube, exceed the rest in size, and these, spreading like rays, form the more salient points of the fringes, while the intermediate spaces are filled up by the smaller appendages.

Intermixed with the latter are often seen minute pedunculated cysts, and especially little white hard grains, the size of millet seeds, first noticed by De Graaf. Similar grains are often observed upon the mesentery of the tube, or attached to the outer surface of the tube itself (*fig.* 404.).

The Tubo-ovarian ligament and fringes. — This so-called ligament (*fig.* 408.) consists of one of the fimbriæ, which is almost constantly prolonged upon the outer margin or base of the triangular mesentery of the tube. Extending in the form of a slight furrow or channel (*fig.* 404. *d* and *fig.* 405. *e*), between the outer extremity of the ovary and the inner or lower border of the tube, it is margined on either side by a row of leaflets, possessing shapes as variable as those which characterise the rest of the lesser fringes. These leaflets, as well as the furrow between them, are backed by a continuation of the peritoneal fold or mesentery, which, after enclosing the tube, here terminates abruptly on a level with its mouth, and thus is produced the appearance of a ligament, whose use is simply to preserve the tubal orifice in contiguity to the ovary; but there is no

reason to think that it performs, as the ancient anatomists supposed, the office of a muscle in drawing these parts together.

The length of the tubo-ovarian ligament determines the distance to which the mouth of the tube can be separated from its corresponding ovary. This, in most instances, is sufficient to permit the tubal orifice to be easily applied over any portion of the gland of the same side; so that from whatever part of the surface of the ovary an ovum is discharged, the reception of the latter by the tube is rendered possible by the range of motion which the mouth of the tube enjoys in relation to the ovary. The average length of this ligament, measured from its commencement at the margin of the ovary to the centre of the tubal orifice is $1\frac{1}{2}''$.

Structure of the coats or tunics. — The Fallopian tube is composed of three coats: — viz., 1. an external investment of peritoneum; 2. a proper coat composed of fibrous tissue; and 3. a mucous lining covered by epithelium.

The tube has been already described as running horizontally within two folds of peritoneum, formed by the upper border of the lesser wing, or ala of the broad ligament, which serves also to form its mesentery, and to connect it with adjacent parts. This fold encircles the tube somewhat loosely, and constitutes the peritoneal coat.

Between this covering and the middle or proper fibrous coat of the tube is found a small quantity of fine and rather tough connective tissue, which serves to bind these coats together. This intermediate tissue being more abundant in quantity towards the uterine end, permits a greater freedom of movement of the serous investment of the tube in this region than at the opposite or free extremity, where, in most subjects, the serous and proper coats cannot be separated without much difficulty.

The middle or fibrous coat has been very generally regarded as containing muscular fibres, and as having a contractile power. Santorini described external, longitudinal, and internal circular fibres, and his statement has been reasserted by Meckel, Boivin, Velpeau, and many others. By Kölliker, also, the middle layer of this tube is regarded as a smooth muscular coat, composed of a double layer of fibres. These statements have been called in question by Robin and Richard, who assert that there are in the proper walls of the oviduct only fibres of cellular tissue and fibro-plastic elements, but no muscular fibres of organic life. M. Richard declares that it is impossible to recognise two distinct layers, at least they can be only artificially produced. The number of longitudinal fasciculi appears always to exceed that of the transverse fibres, but these elements are interlaced in every direction, both longitudinally and transversely.

The question is important, for unless we consider, with Haller, that the proper tissue of the tube resembles the cavernous body of the penis and clitoris, and that, as some have supposed, the tube, when filled with blood, is capable of erection, for which conjecture there appears to be no good foundation, it is impossible, in the absence of a contractile fibrous coat, to explain those movements of the oviduct, which must necessarily occur whenever the abdominal orifice is applied to the surface of the ovary — or that peristaltic action of the tube, witnessed by Bischoff in the Guinea-pig, by means of which the ova are carried backwards and forwards within the canal. See p. 611.

With a view of resolving the doubts raised by these conflicting statements, I have microscopically examined the fibrous coat of the oviduct in the human subject at different periods of life, as well as in several genera of mammalia, and especially in Simia, Bos, Cervus, and Delphinus. With regard to these latter examples, I find the evidence of the presence of a smooth muscular layer, constituting the middle coat of the oviduct, more or less decisive in different genera, but the existence of such a coat was most satisfactorily determined in Delphinus phocæna (pregnant). Here not only were the smooth muscular fibres, collected into long bundles, easily distinguished, but they were still more distinctly shown at the broken extremities of the latter, which exhibited the characteristic fusiform terminations of the individual fibre in such a manner as to leave no doubt as to the muscular nature of the tissue forming the principal portion of this coat, which contained besides an abundance of nuclear elements and common fibres of connective tissue.

With regard to the human subject, it appears to me that the assertion that the middle coat of the oviduct contains only fibrous tissue, may have been based upon the examination of specimens taken from females advanced in life; for, applied to such specimens, the statement is generally true, but in younger subjects, and when the proper reagents have been used, I have experienced no difficulty in finding more or less satisfactory evidence of the presence of smooth muscular fibres, provided only that a sufficiently high power, and the mode of illumination suitable to the discrimination of such tissues, were employed.

It must be observed, however, that the condition of this tissue is very variable. In some subjects, the greater portion appears to consist of nuclear elements which here and there are seen intermixed with fusiform fibres of greater or less length. In other instances, the tissue is more distinctly fibrillar, the fibres being collected in bundles consisting of flattened filaments with distinct fusiform terminations intermixed with bundles of white fibrous tissue; while in some, and, I believe, generally in older subjects, the latter form of fibre, as just stated, abounds, and appears to constitute the principal portion of the middle coat of the tube.

The arrangement of the fibres constituting this coat is chiefly in the direction of the

axis of the tube. This, indeed, appears to be entirely so at the surface; but deeper towards the central canal, numerous flat bundles crossing the former at right angles are encountered, and these become more abundant still nearer to the mucous membrane, although, so far as I have been able to trace them, they do not constitute so distinct and separate a layer as the outer longitudinal stratum.

The general condition of the lining membrane of the tube, and its peculiar arrangement, having been already described, it is only needful here to explain the composition and texture of this coat. This membrane, although commonly regarded as a mucous membrane, contains neither discoverable glands nor villi. It is composed of a very delicate pink or white soft layer, consisting of undeveloped connective tissue, mixed with numerous fusiform formative cells.

This thin layer is united to the fibrous coat by a small quantity of submucous tissue, which is also found lying between the folds of membrane forming the plicæ, or ridges, and serving to connect together the two layers of which they are composed.

Covering this coat upon its inner surface is a thin layer of long cylindrical epithelial cells of a form peculiar to the Fallopian tube, of which Henle has given a minute account.* These, which are conical or filiform, are furnished with an oval flattened nucleus, and have at their broad, unattached end a distinct row of cilia. These cells may be traced through the entire length of the tube, from the uterus to the free border of the fimbriæ, where they gradually diminish in size, and, at the point of junction with the peritoneum, acquire the flattened form of the cells of pavement epithelium.

Under ordinary circumstances, and when the organs are healthy, the canal of the Fallopian tube contains only a small quantity of slightly viscid mucus. But when death has taken place during a menstrual period, the fluid is found to be replaced by blood which is usually of a dark colour, and uncoagulated. This fluid presents, under the microscope, the characters of ordinary blood, with which numerous epithelial scales, derived from the walls of the containing tube, are intermixed.

Blood vessels and nerves. — M. Richard is, so far as I am aware, the only author who has been at the pains to examine and describe with anything like minuteness the precise arrangement and distribution of the blood-vessels supplying the Fallopian tube. The following is his account, the general accuracy of which I have verified by frequent injections of these vessels.

" There exists always a special artery for the tube. Springing from one of the numerous branches of the uterine artery, near the angle of the uterus, this vessel takes a direction from within outwards, from the commencement of the oviduct, as far as the neighbourhood of the pavilion, describing, like the tube itself, a curve, the concavity of which looks towards the side of the ovary. The artery, which is lodged in the substance of the mesentery of the tube, takes a slightly sinuous course, parallel with the oviduct, and at the distance of one or two finger breadths from it. Situated in the middle of the filamentous cellular tissue, which exists between the two layers of peritoneum, it passes constantly behind the organ of Rosenmüller; so constantly, that keeping this relation in mind, one could immediately, if the neighbouring organs were removed, distinguish the anterior from the posterior face of the lesser wing of the broad ligament. The artery is accompanied by the two veins of the tube, and surrounded by very delicate nervous filaments.

" The branches furnished by this artery are lateral as well as terminal. The lateral branches are generally three in number. The first enters the inner third of the body of the tube, at a distance of three or four centimetres from the uterus; the second supplies the middle, and the third the outermost extremity of the oviduct. These three branches before arriving at the tube bifurcate, the twigs resulting from which bifurcations are directed the one to the right and the other to the left to inosculate with each other. From this results a series of arches furnishing branches to every portion of the body of the tube. The innermost bifurcating branch anastomoses with a branch derived from the proper artery of the uterus, so that a well-marked analogy between the distribution of the tubal artery and that of the mesentery is here observable. The terminal division is distributed to the pavilion. It separates into a greater or less number of tortuous branches, each of which goes to supply a fringe of the pavilion; the tubo-ovarian fringes also receive each a twig of the tubal artery. Sometimes, however, a small branch of the utero-ovarian artery, from which it is detached opposite to the external extremity of the ovary, establishes one of the anastomoses between the uterine and the utero-ovarian vessel. From the concavity of the tubal artery very small branches proceed to the organ of Rosenmüller, and to the neighbouring cellular tissue."

But no adequate notion can be formed of the extreme richness of supply of vessels to this and the neighbouring organs until, after a successful minute injection, the parts have been dried and preserved in balsam. Numerous vessels which the opacity of the parts had previously concealed are then brought into view. They are seen running parallel with the surface of the tube, and mostly converging towards the fimbriæ, upon and in the substance of which they lie as thickly as the pile of velvet, previously to their dispersion into their final capillary terminations. It was probably this exuberance of vascular supply that led some former observers to imagine that the tube possessed an erectile tissue, a structure of which the most minute injections do not suffice to exhibit a trace.

The veins, which follow the same course

* Encyclop. Anat. Gen. t. i.

as the arteries of the tube, frequently anastomose with one another by transverse branches, which serve to connect together the two principal trunks. These gather the returning blood and carry it into the plexus of uterine veins placed along the sides of the uterus.

The lymphatics of the tube have the same common source as those supplying the rest of the internal generative organ.

The nerves, which are very slender, follow the course of the arteries. They are derived, according to Dr. Snow Beck, from the hypogastric and aortic plexuses.

Functions of the Fallopian Tube.

It has long been determined, with as much precision as the nature of the subject apparently admits, that the Fallopian tube performs the double office of receiving the ova from the ovary, and conveying them into the uterus, and of receiving the spermatic fluid from the uterus and conveying it in the direction of the ovary: the tube itself being, if not constantly, at least generally, the seat of impregnation; or, in other words, the precise spot in which the material contact of the male and female generative elements takes place.

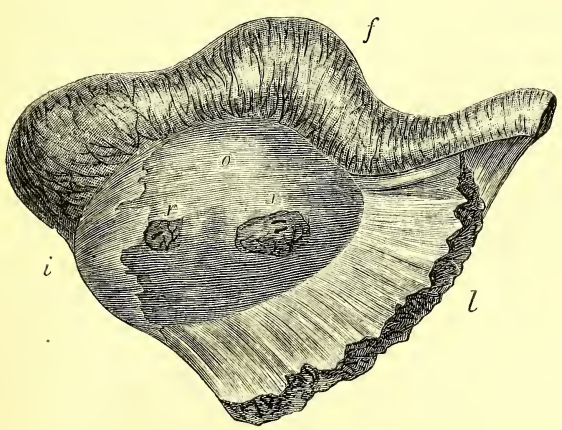
These conclusions regarding the offices of the oviduct, are deducible from various observations and experiments, both of a positive and negative kind, made upon mammalian animals, and the close correspondence which has been observed between these and similar observations, so far as they can be made upon the human female, leads also to the conclusion that there is little or no material difference between the mode in which these offices are performed in man and in the mammalia generally.

With regard to the demonstrative evidence furnished by experiments and observations upon animals, as well as by observations upon the human subject, relative to the precise offices of the oviduct in the conveyance of the ova from the ovary, the following points may be considered as established.

The infundibular orifice of the Fallopian tube, together with the fimbriæ by which its margin is fringed, at the time of the discharge of ova, becomes expanded over a certain portion of the ovary, the extent of the surface covered varying according to the form and proportions of the infundibulum relatively to the size of the ovary.

In some mammalia, the cat for example, the infundibulum is sufficiently large to encompass the entire ovary, so that an ovum escaping from any portion of its surface would fall within the receptacle thus provided for it, and be conveyed to the orifice of the tube, and thence into its canal. But in many animals of this class, as well as in man, the size of the infundibulum does not suffice to cover more than a portion of the ovary at any one time, half or a third it may be of the entire surface of the gland; so that in all these cases a selection must be made of the exact spot from which the discharge of an ovum is about to take place, or else the ovum would be lost, by falling into the cavity of the abdomen. That this occasionally happens is rendered evident by those cases in which the infundibulum is glued as it were to a portion of the ovary by morbid adhesion. But while the extremity of the oviduct is thus immoveably fixed, the process of ovulation still goes on from all parts of the ovarian surface indifferently, so that those ova only which might happen to be discharged from the particular spot to which the tube is affixed, would by any possibility enter its

Fig. 409.



Ovary of a woman who died during menstruation.

The coats of the ovary are attenuated in two places. Three apertures, *r r*, two being in juxtaposition, lead to as many Graafian vesicles from which ova have been recently discharged, escaping apparently into the cavity of the abdomen. The infundibulum is glued to the extremity of the ovary by morbid adhesion. The tube is distended by accumulated fluid; *o*, ovary; *i*, infundibulum; *f*, Fallopian tube; *l*, broad ligament. (*Ad Nat.*)

mouth, and all the rest would be lost. I have already adverted at p. 560. to such an example, and of this case a drawing is here subjoined. In this instance, three ripe Graafian vesicles had burst on one side of the same ovary, and had discharged their ova, while the mouth of the corresponding oviduct was inseparably united by morbid adhesions to the outer extremity of the gland, and was thus effectually prevented from receiving any ova except such as might be discharged from the spot to which the tube was attached.

By what power the mouth of the tube is directed to the particular portion of the ovary from which an ovum is about to be discharged remains entirely unknown, as, indeed, does also, to a certain extent, the precise nature of the mechanism effecting this movement. The part termed the tubo-ovarian ligament (*fig.* 404. *d*) will at all times serve to keep the infundibulum in contiguity with the ovary, but by what agency the orifice of the tube is drawn towards, and its fimbriæ become expanded upon, the ovary, cannot be very satisfactorily explained. These movements can only be referred to the contraction of the low form of fibre of which this part has been shown to be chiefly composed ; and although it is certain that in a great many of the invertebrata, a similar form of contractile fibre constitutes the sole agency by which their active and sometimes very rapid movements are effected, yet this is not commonly found to be associated with any considerable degree of movement in the higher animals.

The temporary adhesion of the infundibulum to the surface of the ovary when an ovum is about to be discharged, appears to be effected by the interposition of a slimy mucus, which possesses sufficient tenacity to require the employment of some slight force in drawing the parts asunder, and which is furnished, probably, by those numerous minute folds or plicæ so plentifully covering this portion of the tube.

It was formerly supposed that this apposition of the mouth of the tube to the ovary occurred only under the influence of the sexual orgasm ; an inference which was natural so long as the belief remained general that the ova were discharged from the ovary only as a consequence of sexual congress. But this circumstance admits of a modified explanation, now that the discharge of the ovum in mammalia is known to occur during the "heat," or that period in which alone the coitus is permitted by the female. The apposition of the Fallopian tube to the ovary at such times is to be regarded as a movement providing for the safe passage of the ova to the uterus, and, in regard to time, as preceding the act of impregnation, although it might endure until after a fertilising coitus had taken place, and so the parts would occasionally be found in such a state of apposition in an animal killed immediately or shortly after that event ; thus appearing to warrant the conclusion that the venereal orgasm had been the cause of this movement. The mode in which the ovum is expelled from the ovary has been already described at p. 560. In the form there represented, the ovum is received into, and is conducted along, the Fallopian tube ; and, on account of the interest which attaches to the earlier developmental changes occurring here, it has, perhaps, been more frequently examined in this situation than in any other portion of the generative track. Barry's tables include the particulars of ninety-three ovula, found in various parts of the tube in the rabbit, between 10 and 70 hours post coitum. Bischoff's observations were made upon 60 or 70 ovula within the tube in the same animal, as well as upon many more in other mammalia. Several instances of the same kind have been already quoted, two of these being in the human subject; and almost every anatomical collection contains examples of the human ovum abnormally arrested and developed in the tube.

In what way the ovum, after its reception by the mouth of the tube, is conveyed along that canal into the uterus, is explained by the peculiar construction of this part. The tube being lined longitudinally by slender folds which divide it into numerous capillary canals, and having every part of its inner surface covered by cilia, vibrating, according to Henle, in a direction towards the uterus, appears admirably adapted for the conveyance of the minute ovum downwards from the place of its formation to its seat of normal development. The peculiar form of the oviduct, which is more or less funnel-shaped, especially in the human subject, further conduces to this direction of the ovum downwards, while, in many instances, its course appears to be aided by that peristaltic action of the walls of the tube which many observers have noticed, and of which a further account will be presently given.

The period of time occupied by the descent of the ovum through the tube does not usually exceed a very few days. This, however, appears to be a variable feature in different mammalia, and regarding which, even in those animals admitting of the readiest observation, it appears very difficult to arrive at definite conclusions, chiefly on account of the uncertainty belonging to the determination of the precise moment at which the ovum quits the ovary.

In the bitch the ovum, after quitting the ovary, is supposed to remain in the tube susceptible of impregnation during 6 or 8 days; and its passage is probably quite completed in 10 days. In the guinea-pig the ovum makes its passage in a much shorter time, as it usually enters the uterus at the end of the third day. In the rabbit the time is nearly the same. The ovum, surrounded by a thick layer of albumen, passes from the oviduct into the uterus at the end of the third or beginning of the fourth day. While in the roe, although the time occupied is probably longer, yet, at the most, in a few days, the

ovum, unaltered in size, as in other cases where it receives no albumen in the tube, reaches the uterus, and there, if impregnation has taken place, it remains four and a half months without undergoing any positive change. In man little is known accurately respecting the time occupied by the passage of the ovum through the tube. Only two instances have been recorded in which the human ovum has been actually seen in the tube (see p. 567.), with the exception of abnormal cases.

The attempt to determine this point in the human subject has generally proceeded upon a comparison of the condition of early ova found in the uterus, or prematurely expelled from it, with the last known date of intercourse or of menstruation; but neither of these modes of calculation can afford any certain information: for it is obvious that the first can give no more than the date of insemination (as, for example, when a single intercourse has occurred), but will throw no light upon the question of the time which may have elapsed since the ovum quitted the ovary, and how long it may have remained unimpregnated in the tube; while the second mode is rendered equally uncertain for want of more precise knowledge than we at present possess of the actual relation in point of time between menstruation and ovulation. See p. 669.

The analogies which other mammalia furnish justify, to a certain extent, the supposition, that the time occupied by the passage of the ovum through the tube in man is not materially different. But the circumstance that, in man, the periods of capacity for impregnation are not restricted to definite occasions, to the same extent that they are in brutes, greatly diminishes the value of any calculations which might be based upon these analogies.

We may next examine the evidence by which it may be shown that the Fallopian tube serves, on the other hand, as a conduit for the spermatic fluid towards the ovary. That it performs this office, in addition to that of conveying the ova downwards into the uterus, is abundantly proved by the direct observations of Prevost and Dumas, Bischoff, Barry, Wagner, and many others; whose experiments serve to show, also, to what extent the spermatozoa are capable of penetrating within the tube, and of retaining their power of motion there.

Bischoff, after repeatedly finding spermatozoa in active movement in the vagina, and particularly in the Fallopian tube of the bitch, though in this latter situation the movements had ceased, was so fortunate as to trace them in an animal that had been lined on two successive days, and was killed half an hour after the last coitus, not only in the uterus, but also in active motion through the whole length of the tubes, and between the fimbriæ, and finally in the sac or capsule which the peritoneum forms around the ovary, and even upon the ovary itself. Wagner also found in a bitch, killed forty-eight hours after coitus, spermatozoa motionless in the vagina but active in the uterus, in whose cornua, as well as in the Fallopian tubes, their number and activity conspicuously increased as far as the abdominal extremity, where they completely filled every fold of membrane, and were seen moving among the fimbriæ, but none were found in the capsule or pouch that surrounds the ovary. By Barry the same fact of the possibility of the spermatozoa penetrating to the utmost extremity of the tube, and even as far as the surface of the ovary, has been demonstrated. Of the latter he gives two instances; but that the seminal fluid does not commonly penetrate so far as the ovary may be inferred from the statements of Prevost and Dumas, who could never find them in this situation, and of Barry, who, acknowledging the accuracy of those observers, says himself, that in seventeen out of nineteen instances in the rabbit, he was unable to detect the spermatic fluid upon the ovary, and in one of the two cases in which he had observed it there, the only evidence of the fact was the presence of a single spermatozoon.

By no observer, so far as I am aware, have spermatozoa ever been detected within the ovary of any mammal.

The rapidity with which the spermatic fluid is capable of reaching and entering the tube is sometimes very considerable. Bischoff has observed spermatozoa within the oviduct of the Guinea-pig immediately after the coitus; in one instance, indeed, he traced them as far as the middle of the tube, in little more than three quarters of an hour after that event, though it had been commonly supposed that a period of nine or ten hours was requisite for the penetration of spermatozoa to the extremity of the tube.

The power by which the semen reaches the oviduct is partly the act of ejaculation, which may suffice to carry it to the end of the uterus, partly the peristaltic action of the uterus and tubes, in those animals in which these parts have flexible walls; partly, also, the movements of the spermatozoa themselves. But the cilia lining the tubes can in no way contribute to this effect, since their action would create a current in the contrary direction to the ascent of the fluid.

Thus it has been shown that the Fallopian tube, or oviduct, performs the double office of conveying the ova from the ovary towards the uterus, and of serving as a conduit for the passage of the spermatic fluid from the uterus towards the ovary; and the conclusion is almost inevitable, that, by these combined operations, the encounter of the generative elements will most probably take place at some point within the tubal canal. It may, however, be objected, that since the spermatic fluid has been known occasionally to reach as far as the ovary, impregnation may occur there; or, on the other hand, that inasmuch as this fluid must necessarily, in part at least, fill the uterus before it can occupy the

oviduct, the ovum may not become impregnated until after it has reached the principal cavity of the generative track.

In order, therefore, to determine as nearly as possible the precise limits of the functions of the oviducts, it will be necessary to examine more particularly the evidence, which serves to show, that while the ovary is the part in which the ovum is formed, and the uterus that in which it is developed; the Fallopian tube, besides being the conductor of the ovum from the formative to the recipient organ, is also the seat of the second most important step in the process of generation, namely, its fertilisation.

Here human physiology is so much at fault that it again becomes necessary to resort to the evidence furnished by experiments, and observations made upon the mammalia generally.

Now, one of the most remarkable circumstances relating to the generative process in the mammalia is, that the periods of separation of the ova from the ovary, and of their passage down the Fallopian tube, are coincident with the œstrus. Bischoff, indeed, has ascertained, in the bitch, that by the time the ovum has reached the uterus, or even the lower end of the oviduct, the period of heat, or desire for sexual congress, has passed away, and consequently the opportunity for impregnation is lost. In the Guinea-pig also it appears certain that the opportunity for impregnation is already gone by the time the ovum has quitted the tube, and has reached the uterus; for the œstrus is then long passed, the coitus has long ceased to be permitted, and even the vulva is at this time again contracted. And although doubtless these conditions vary in different genera, yet a variety of circumstances, of which a more particular account will be presently given, renders it probable that the rule is general among the mammalia, that insemination shall occur coincidently with the passage of the ovum down the Fallopian tube.

Next, it may be shown, by the experiments of Cruikshank, Haighton, Blundell, and Bischoff, which consisted in deligation or excision of portions of the tube, that whenever the obliteration of the canal was complete, and had been effected prior to the act of copulation, fertilisation of the ovum was rendered impossible.

These experiments were most satisfactory when performed on one side only of the generative organs, so as to leave free play for the natural functions of the other; and thus the negative results obtained on the one half of the body being set off against the positive ones of the other, served to enhance the value of both. By such experiments it may be shown that mechanical obstruction of the tube, while interfering in no respect with the spontaneous separation of the ovum from the ovary, or its reception by the mouth of the tube, and descent as far as the seat of obstruction (provided indeed that care is taken in the experiment not to destroy the vascular supply of the parts), prevents the completion of the reproductive act, and stops it at this stage, by impeding the access of the spermatic fluid to the ovum.

But the results of such experiments will necessarily vary according to the time and place of application of the ligature. Thus while division or deligation of the tube before, or even very shortly after, intercourse prevents impregnation of the ova, yet, according to Haighton, the same experiment performed sixty hours after coitus had no effect whatever in impeding the development of the embryo, for in that time the encounter of the generative elements would have already taken place.

But although these experiments may be infinitely varied, they cannot afford such satisfactory information as may be derived from the actual examination of the contents of the tube where natural impregnation has been allowed to obtain, especially when these examinations have been conducted with the aid of the microscope. In this way may be obtained an amount of collective evidence that leaves little to be desired for the purpose of fully elucidating the history of the ovum during that brief but important period which intervenes between its quitting the ovary and its entrance into the uterus. But since an account of the development of the ovum does not come within the scope of this article, only so much of the subject will be given here as will be requisite to continue the argument for the purpose of showing what is the precise part which the Fallopian tube takes in the process of impregnation.

There can be no question that the mammalian ovum, after an efficient coitus, enters the uterus in a condition differing in many important particulars from that in which it ordinarily quits the ovary. And although a certain amount of variation is perceptible in regard to the actual changes experienced by the ovum in different species, during its passage through the tube, yet so constantly are the main features preserved, that the observations made upon any one species will generally serve as a type of the rest, and certainly the aggregate of these observations, agreeing closely as they do with one another, render the conclusion in the highest degree probable, that changes not very different from these occur also in the ovum in man.

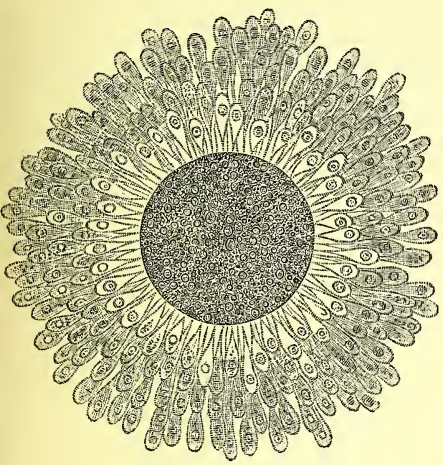
Barry asserts that "there is no condition of the ovum, uniform in all respects, which can be pointed out as the particular state in which it is discharged from the ovary." Nevertheless the ripe ovum which is about to be expelled, or one which has been just discharged, presents certain well-marked characteristics, of which the following are the most important.

The ovum is closely invested by a layer of nucleated cells. These form a portion of the granular membrane or lining of the Graafian follicle in which it is imbedded, and when the ovum is discharged from the follicle, as described at p. 560., a portion of these gra-

nules is carried with it into the mouth of the Fallopian tube.

In ova which are not quite ripe, these nucleated cells are round, but during the œstrus, in the riper ova, the cells become elongated and fusiform, having their pointed ends attached to the zona pellucida or bounding membrane of the ovum. They present a glassy swollen aspect, by which the fully ripe

Fig. 410.



Ripe ovum from the ovary. Guinea-pig. (After Bischoff.)

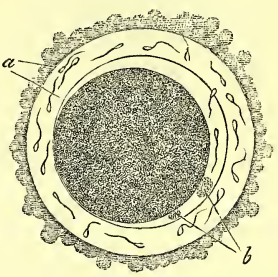
ova acquire an appearance of being surrounded by rays. This change occurs in most mammalia, as the dog, rabbit, sheep, rat, roe, and kangaroo. It is characteristic of the mature ova, and may be regarded as a certain sign of their ripeness.

Corresponding with this external alteration in the appearance of the ovum, are certain internal changes, of which the chief is the disappearance of the germinal vesicle. This indeed seems to be an almost constant phenomenon throughout the mammalia, though, as to the precise mode, or even time, of disappearance of this important constituent of the ovum, observers are by no means agreed. By Barry it was considered, after close observation, that the vesicle was not dissolved nor ruptured, as many now suppose, but that it became lost to observation by retiring to the centre of the ovum, where it was changed in character by an internal process of cell development.

These changes, external and internal, are the precursors of impregnation, and characterise the ovum shortly prior to and at the period of its quitting the ovary.

Arrived within the Fallopian tube, the first alteration which the ovum experiences is the stripping off of the ray-like appendage of nucleated cells with which it quitted the ovary. This change results apparently from a bursting and diffluence of these cells, now no longer capable of serving any useful purpose; for the conjecture that they might furnish materials for the construction of the chorion has not been supported by any direct observations. On the contrary, numerous observations of Bischoff show that this process of freeing the ovum from its surrounding layer of cells, takes place very soon after its entrance within the tube, and generally in the upper third.

Fig. 411.



The ovum on first arriving in the Fallopian tube. The ray-like appendages are nearly stripped off. (After Bischoff.)

a, zona pellucida; *b*, granular bodies between the zona pellucida and yelk. Rabbit.

And now, if the coitus does not obtain, and no contact of the generative elements occurs, the ovum perishes; observations at least relative to its further fate are wanting. But should the ovum have become fertilised, then a noticeable series of changes takes place, of which the following are the most important.

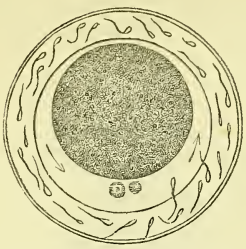
The zona pellucida, or transparent bounding membrane of the ovum, having been freed of its external granular investment, the entire ovum presents the condition represented in figure 412. Deprived now of all encumbrance, the surface of the ovum is in a condition eminently favourable for the passage through it of the spermatozoa, which penetrate readily that soft outer coat, and thus gain admission to the yelk.

The fact of the penetration of the outer coat of the ovum by the spermatozoa, which has been so often asserted and denied, may now, after much controversy, be considered as established. In the mammalian ovum, this passage may take place apparently through any portion of the outer coat, just as it does in the ova of amphibia, and not through a special pore or microphyle, such as exists in the ova of osseous fishes.

Following this act of penetration occurs a change which apparently affords the first distinct evidence that the power of the spermatozoa has been efficiently exerted upon the ovum. The yelk, which had previously completely filled the zona, is observed to have become contracted, so that an interspace is left between it and the zona, termed by Newport, who has carefully watched its formation in the ova of amphibia, the "respiratory chamber." Such a retiring of the yelk, so as to leave an interspace between

the latter and the zona pellucida, which interspace is filled by a transparent fluid, has been noticed in many mammalia, as the Guinea-pig, rabbit, &c.

Fig. 412.



The ovum a little more advanced in the tube. (*After Bischoff.*)

The surface is perfectly smooth. Spermatozoa have penetrated the zona pellucida. The respiratory chamber is formed between the latter and the yelk. The rotation of the yelk has commenced, as indicated by the arrows. The granular bodies appear preparatory to the segmentation of the yelk. Several of these stages are seen commencing in the preceding figure. Rabbit.

This change is preliminary to another occurrence, which has been observed in the ova of many animals, both vertebrate and invertebrate, viz. the rotation of the yelk within the interspace just described;—a rotation which is effected by the aid of cilia clothing the surface of the yelk.

About this time may be observed one, or perhaps two, small granular bodies, whose formation has given rise to many and varied speculations regarding their signification and use. They occupy a portion of the space between the yelk and zona pellucida, and appear to be common to the mammalian ovum and that of other classes. The most probable supposition regarding their use connects them with the division or cleavage of the yelk which follows their appearance.

Whatever doubts may be entertained as to the dependence of the phenomena already described upon a preceding act of impregnation, all question is set at rest at this point, by the direct experiments of Newport, who ascertained beyond doubt, that segmentation of the yelk is the result of impregnation alone, and that it never takes place in the unimpregnated ovum.

This segmentation of the yelk consists in a spontaneous cleavage of that body, at first into two, and then into four, equal parts; the process of division continuing in geometric progression until the whole is broken up into a mass of finely nucleated particles, between which the original sperm-force is probably equally divided.

Segmentation of the yelk of the mammalian ovum has never been observed in its commencing stages anywhere but in the tube. The extent to which it proceeds before the ovum quits the oviduct to enter the uterus appears to vary in different species. Bischoff never saw more than four yelk-divisions in the ovum of the Guinea-pig by the time that it had reached the lower portion of the tube; and it is probable that a further division into eight parts occurs in the extreme end of the duct, since, in the next condition of the ova found in the uterus, the yelk exhibited 12—16 divisions.

Fig. 414.

The ovum from the lower or uterine end of the Fallopian tube. (*After Bischoff.*)

The yelk exhibits four divisions. Rabbit.

The only remaining change in the condition of the ovum during its residence in the ovi-

Fig. 413.

The ovum still more advanced in the tube. (*After Bischoff.*)

The first stage in the segmentation of the yelk has taken place. Rabbit.

Fig. 415.

The addition of a layer of albumen in the lower portion of the tube—(*observed only in the rabbit.*) (*After Bischoff.*)

The yelk exhibits eight divisions.

duct, which it is necessary here to notice, is the addition, sometimes, of a thick layer of albumen around the zona pellucida, which is formed upon it in the middle and lower portions of the tube. But this is certainly not a constant, and apparently not even a common occurrence. It occurs in the rabbit, but not in the bitch, Guinea-pig, or roe.

These are the principal and more obvious changes which the ovum experiences in its passage down the Fallopian tube until it enters the uterus. So regular is the order with which they succeed each other that particular portions of the tube may be assigned as the seat of each occurrence. Thus the first, or upper third of the oviduct is appropriated to the reception of the ovum, which, soon after quitting the ovary, is here deprived of its adventitious covering of nucleated cells, and is thus prepared for the full operation of the spermatozoa, whose active movements in this part of the tube have been frequently noticed. Here also spermatozoa have been frequently seen upon, and even within, the ova; and here the first changes characteristic of the commencing operations of the sperm force, such as the formation of the respiratory chamber, and rotation of the yelk, may be noticed. In the middle of the tube the ova commonly exhibit still more decided evidences of impregnation. The cleavage of the yelk has already commenced, and one or more granular bodies occupy the space between it and the zona. The ova found in the lower third, except those which may be destined to perish, always show unmistakable signs of impregnation, of which the segmentation of the yelk, now advanced to the production of 12—16 divisions, is the most expressive.

If the views of Bischoff be correct, it is in the upper third, or at farthest in the middle of the tube, that impregnation must occur, unless indeed it takes place at the ovary. For in the lower end of the tube the more definite developmental changes of the ovum occur, or otherwise the ovum perishes. In the dog and Guinea-pig, by the time the ovum has reached this spot, the œstrus is past, and the animal will no longer permit the coitus.*

Connected apparently with some of the foregoing steps in the process of generation, though it does not appear precisely with which, is a phenomenon described by Bischoff as occurring in the Guinea-pig. Several times Bischoff had the good fortune to observe with a lens, and also under the microscope, a peristaltic action in the walls of the oviduct, by which the contained ova, visible through them, were moved backwards and forwards. The ova appeared to be surrounded by a transparent fluid, in which they floated.

Now, such an observation is interesting, when viewed in connexion with two circumstances, specially observed and proved by Newport, namely, that in the artificial impregnation of the ova of amphibia, although the process of impregnation is *commenced* at the instant of contact of the spermatozoa with the ova, yet a certain duration of contact is essential to its *completion*. And further, that although an exceedingly minute quantity of spermatozoa suffices to impregnate the ovum, yet impregnation takes place more tardily when the number is extremely limited than when the number is in full abundance; while when the quantity is reduced below a certain amount, or the duration of contact is limited, then the phenomenon is incomplete, and partial impregnation, evidenced by imperfect segmentation of the yelk, and arrest of the further stages of development, is the inevitable result.

Since, then, it cannot be supposed that a less perfect or complete contact of the ova with the spermatozoa is needful to their impregnation in the higher than in the lower vertebrata, there seems to be good ground for conjecturing that this peculiar peristaltic movement in the walls of the Fallopian tube, which has been noticed also by other observers, may have for one of its objects the more perfect commingling of the two generative elements, the spermatozoa and the ova, which, proceeding as they do in opposite directions, and encountering each other in some portion of the canal, would thus be carried backwards and forwards, and thus a certain permanence of contact, such as Newport has shown to be necessary in the amphibia, would be insured to them. And this supposition may be further strengthened by the reflection that while an onward movement in either direction would serve for the conveyance of each element singly along the tube, a backward and forward motion alternating could only retard either or both processes, and that there could be only one apparent advantage in such retardation, namely, the retention of both elements for a longer or shorter time in permanence of contact.

To sum up the offices of the Fallopian tube, the following may be said to have been with certainty ascertained to belong to that division of the generative organs: To receive the spermatic fluid from the uterus and convey it upwards through the entire canal, and as far sometimes as the ovary; To receive contrariwise the unimpregnated ova, as they are discharged from the ovary, by means of its expanded open mouth, which in these cases, where the entire ovary cannot be grasped, is guided, by a process hitherto unexplained, to select and apply itself to that

* Pouchet (L'Ovulation Spontanée) places the seat of impregnation lower down in the oviduct. He asserts that it is only about the middle of the tube, or more particularly in its lower portion, and even in the cavity of the uterus itself, that the material contact of the ova with the spermatozoa can occur. And he regards the passage of the semen as far as the extremity of the tube, and its arrival at the ovary, as an "excessively rare anomaly." But these statements are based upon examinations directed only to the detection of the presence of spermatozoa in the oviduct, and are not connected with microscopic observations of those developmental changes in the ovum, which are indisputably the results of impregnation, and of which an account has been given in the text.

particular spot from which the ripe ovum is about to be expelled; to convey the ovum in a direction opposite to the course of the fertilising fluid, so as to ensure the meeting and commingling of the generative elements, an event to which the limited calibre joined to the peristaltic action of the oviduct probably in a great degree contributes; to afford protection to the ovum during that brief sojourn in which the first effects of fertilisation are manifested upon its constituent parts; to aid probably in certain changes which are operated upon the surface of the ovum, consisting first, in all cases apparently, in a stripping off of the adventitious covering with which the ovum is invested on entering the tube, and secondly, in some instances, in the addition of certain materials which increase slightly the bulk of the ovum; and lastly, in transmitting onwards the ovum, so altered and prepared for more complete development, to the cavity of the uterus, or in conveying away those which, for want of impregnation, are destined to perish.

In reference to these conclusions regarding the offices of the Fallopian tube, which the present state of physiology appears to warrant, the question here naturally arises, how far they are applicable to the female of man, or to what extent her case may be viewed as exceptional on account of certain differences in her organisation and habitudes.

One of the most observable of these differences is the absence of that marked distinction of periods alternating with each other, such as are shown in a greater or less degree in the females of most mammalia in regard to the activity of the sexual functions.

That these alternating periods of desire and aversion to the coitus are strictly significant of corresponding temporary states of physical capacity and incapacity for conception, is placed beyond doubt, by the results of examination of the internal organs and their contents at these respective periods.

In those animals in which the œstrus returns at short intervals, the male generally remains potent at all times. The temporary incapacity is on the side of the female, and occurs in the *intervals* between the successive acts of ripening and discharge of the ova from the ovary, together with their passage down the tube. It has been shown that during these events only will she receive the male, and therefore, on that account also, is conception then only possible.

This circumstance is rendered more striking in animals in whom this interval is longest, as in the roe-deer, where the œstrus returns only once annually, and in whom the capacity for procreation is limited to a few weeks, for the reason stated by Bischoff, that then the ovary contains ripe ova and the testes ripe semen, and at no other time.

But in the human female, whatever views may be entertained regarding the connexion of a separate act of ovulation with each menstrual period, it is certain that here a marked œstrus is wanting, and that although the capacity for impregnation is apparently greatest about the times of menstruation, yet, notwithstanding the assertions of those who maintain that there is a perpetual recurrence of temporary incapacity for procreation, there is no period at which the healthy human female can be shown to be positively incapable of conception during any part of menstrual life.

It may, however, be asked whether the occasional occurrence of impregnation during an intermenstrual period, at a date more distant than usual from the last menstrual act can be explained consistently with a strict interpretation of the law that menstruation and ovulation are contemporaneous acts.

This appears to be reconcilable with the circumstance that although these acts, so far as observation has yet gone, are very frequently and perhaps usually coincident, yet exceptionally an ovum may be emitted during an intermenstrual period, the *ripening* and not the time or the act of emission of the ovum being probably the essential feature, or that the ovum, supposing it to have been emitted from the ovary at the time of menstruation, may possibly remain in the tube susceptible of impregnation longer in the human female than in the mammalia generally, or may even be impregnated after reaching the uterus. *

That the Fallopian tube in the human subject is, occasionally at least, the seat of impregnation, is demonstrated by the occurrence of the tubal form of extra-uterine gestation; while the numerous examples already quoted of other mammalia render it highly probable, by analogical reasoning, that this is the *normal* seat of that function in man.

That the first encounter of the generative elements may also take place either in the uterus or upon or even within the ovary, is plainly possible. That it occurs sometimes at or near the ovary is evidenced by the varieties of extra-uterine gestation termed ovarian and ovario-tubal. It is even possible that, in some of these, insemination may have been so coincident with the spontaneous opening of the Graafian follicle, that the spermatozoa, penetrating further than usual, may have reached the ovary at that precise moment when a passage had been prepared for the ovum, and some may have actually passed into the follicle and have impregnated the ovum there. No argument certainly can be opposed to this on the ground of physical impossibility †; while, on the other hand, it is also conceivable that impregnation may be delayed until after the ovum has entered the uterus, as in the case just suggested of a fertilising coitus occurring later than usual after the menstrual period; but I am not aware of any good anatomical or physiological reason for regarding the uterus, as by pre-

* These points are more fully considered under the head "Menstruation," p. 668.

† See the argument regarding the anatomical evidence for this form of gestation at p. 586.

ference, the seat of normal impregnation; while such a view is opposed to those numerous observations upon the mammalian ovum generally, which show, that before the ovum quits the oviduct, the developmental changes in it are already advanced many stages, while, by the time that it arrives at the uterus, the opportunity for impregnation has already passed away for that occasion.

Development of the Fallopian Tube.

Whatever difference of opinion may exist regarding the origin of the excretory duct of the male generative gland, there appears to be no doubt, that in birds at least the corresponding part in the female has its commencement in a structure which, as soon as it can be recognised as a distinct tube, is altogether separate from the Wolffian body. This is called after its first observer, the duct of Müller* (*fig.* 400. *g*).

The mode of origin of this duct has been already partly described in the account which has been given of the formation of the Parovarium (p. 594.). Its development may be most conveniently traced in birds, where it can be easily shown that the oviduct is not a metamorphosis of the excretory duct of the Wolffian body, but may be distinguished lying near it, in the form of a tolerably thick tube; which at first ends in a closed extremity, but afterwards exhibits a wide orifice. It runs along the outer side of the Wolffian body, while its infundibulum, which is soon distinguishable, extends beyond and is entirely separate from that body.

The oviducts appear from the first in the form of white cylinders on both sides. They do not grow from below upwards, but are formed in their entire length from the commencement; nor are they constructed out of a membranous lamina, rolled together, as Meckel supposed; but are in the beginning solid, and become gradually hollowed out into a tube. In this way also is formed the infundibular opening of the tube into the abdominal cavity.

Two oviducts exist originally in all birds, but as in this class the right ovary shrinks and disappears, so the right oviduct becomes lost, by gradually contracting and shortening from above downwards. †

In mammals, before the distinction of sex becomes apparent internally, there is seen, running along the Wolffian body of each side in every embryo, a duct, which, according to Müller, may represent either a vas deferens, or an oviduct. These ducts lie upon opposite sides of the germ glands, which may become afterwards testis or ovary.

Soon afterwards the internal organs begin to exhibit a distinction of sex. This is indicated in the future male by the duct, which runs along the outer side of the Wolffian body, sending off a white granular projection, extending towards the testis, which is met by a similar projection, given off by the upper end of the testis, and these two by their union form the rudiments of the epididymis. So that in the male mammal a new connexion is established between the duct, which afterwards becomes vas deferens, and the testis, without any agency from the Wolffian body, but through the development of new material.

In the female these projections are wanting, both from the excretory duct and from the ovary. The latter remains attached only to the Wolffian body by a simple fold. The upper end of the duct, which runs over the Wolffian body, projects somewhat beyond that body inferiorly, and terminates here in a globular swelling, in which an aperture is formed at a later period.

As the Wolffian body becomes atrophied the portion of the duct which takes its course over it, and which was previously straight, begins to be tortuous in the male, while in the female it remains straight, but becomes wider. Out of corresponding portions of the duct are formed, in the male, the head of the epididymis, and in the female the infundibular end of the tube, while the inferior free portion of the duct, after it has quitted the Wolffian body becomes converted, in the male, into the vas deferens, becoming at the same time more and more elongated; but in the female the corresponding portion of the duct is transformed into the inferior division of the tube, or into the cornu of the uterus.*

In this stage of its development the incipient Fallopian tube is only beginning to be recognisable. It circumscribes the diminishing Wolffian body on its outer side in the form of a bow. Above the superior opening extends beyond that body, while below the short free portion becomes conjoined with that of the opposite side to form a single tube. These ducts have throughout the same breadth up to their union with each other.

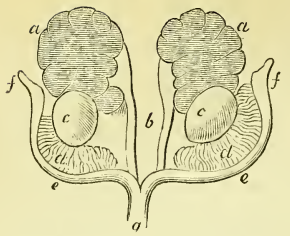
A division of the duct into uterus or cornu, and narrower Fallopian tube, is still nowhere perceptible, and the place of this latter division is only as yet indicated by the addition of the substance which afterwards becomes ligamentum rotundum. Between the oviduct and the ovary lies the atrophied Wolffian body of a dirty yellow colour, in part surrounding the ovary; but notwithstanding this contiguity the tubuli of the Wolffian body form no union between the Fallopian tube and the ovary. The duct, or future Fallopian tube, which had previously preserved a perpendicular direction, now takes, with the rest of these parts, a more sunken position. But it still lies close to the Wolffian body, from which it is separated by a narrow fold of peritoneum.

* See Müller's Bildungsgeschichte der genitalien. Düsseldorf, 1830.

† Prof. Quekett has pointed out to me, in the collection of the Royal College of Surgeons, a remarkable preparation by Mr. Tegetmeir, in which the right oviduct is developed in the common fowl.

* The researches of Kobelt upon this subject have been already explained under the head of development of the Parovarium.

Fig. 416.

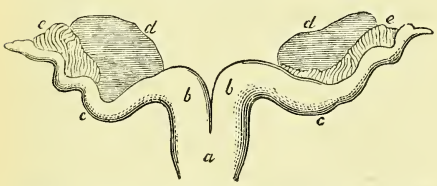


Genito-urinary organs of a fœtal sheep. (*After J. Müller.*)

a, kidneys; *b*, ureters; *c*, ovaries; *d*, Wolffian bodies; *e*, uterine cornua and Fallopian tubes; *f*, infundibular end of the tubes; *g*, middle portion of the uterus.

In older female embryos the Fallopian tubes, now more completely formed, are thicker and exhibit a somewhat undulating outline. The

Fig. 417.



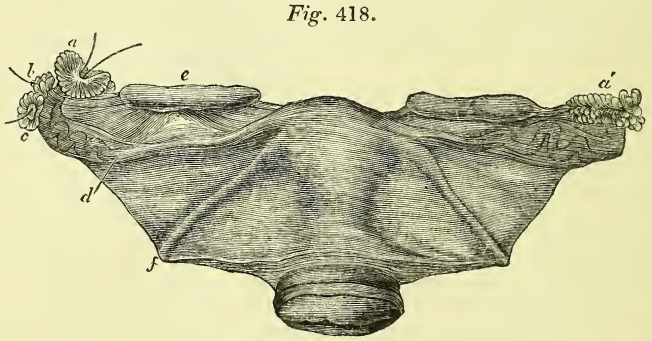
Internal generative organs of a fœtal deer. (*After J. Müller.*)

a, middle portion of the uterus; *b*, cornua; *c*, Fallopian tubes or oviduct; *d*, ovaries; *e*, remains of the Wolffian bodies.

Wolffian bodies, much reduced in size, may be found lying in a duplicature of peritoneum, between the ovaries and the oviducts. The inferior portion of the latter becomes widened, and the division between the tubes and the horns, or *cornua*, of the uterus is established ; although the tube still remains relatively very broad, even up to its abdominal end.

In the human subject the opportunities for observation upon very early embryos being of not very frequent occurrence, the foregoing changes have not been so accurately traced in the first stages as in the embryos of birds and mammals ; but all the examinations which have yet been made lead to the conclusion that the Fallopian tube has its origin in a duct similar to that already described. This, with the rest of the internal organs, is sufficiently developed by the third month of utero-gestation to leave no longer any doubt as to the sex. By this period the oviducts have nearly acquired that horizontal position which, from the fourth month onwards, becomes a more marked characteristic. In embryos of the fourth month the tubes run parallel with the now horizontally placed ovaries, whose elongated form corresponds with the tube in the greater portion of its length. By the end of this month the abdominal end of the tube is seen to be wide open, and traces of the fimbriæ are discoverable in its already fringed margin. The lower ends of the tubes are still not so completely united but that an indentation is perceptible at their point of junction, giving evidence of the still bi-corned condition of the uterus. From this period onwards the proper structure of the tube wall appears to grow with greater rapidity than the fold of peritoneum by which it is invested ; so that in advanced embryos, and in the fœtus at term, the oviduct is usually found of a tortuous or serpentine form, its windings being easily distinguishable through the peritoneal sheath. The tube now much exceeds the ovary in length, and its infundibulur end is beautifully margined with delicate fimbriæ (*fig.* 418.).

Fig. 418.



Uterus and appendages of human fœtus at term. (*After Richard.*)

á, pavilion of the left side; *a*, the same of the right side (below it, in this specimen, is the remarkable variety of two separate accessory pavilions *b* and *c*); *d*, Fallopian tube, exhibiting numerous sinuosities in its outer half; *f*, round ligament; *e*, ovary.

Abnormal Anatomy of the Fallopian Tube.

Defect and Imperfect Development. — Absence of the Fallopian tube is of infrequent occurrence, and is usually observed in cases where there is a coincident deficiency of the uterus or ovary.* But when the two latter

* Meckel, Handbuch der Patholog. Anatomie, B. I.

organs are perfectly formed it is exceedingly rare to find a deficiency of the oviduct.

The oviduct may be deficient either upon one or both sides. Heusinger * has recorded an example of deficiency of the ovary and Fallopian tube of one side.

Chaussier † met with a remarkable example of a woman who, notwithstanding the absence of one ovary and tube, and even of one side of the uterus, bore ten living children; and whose death shortly after her last confinement afforded him the opportunity of ascertaining this peculiar condition of the parts.

After the observations which have been made regarding the function of the Fallopian tube, it is hardly necessary to observe here that deficiency of both tubes will be necessarily productive of permanent sterility; although absence of the tube of one side, as in the case of Chaussier, just quoted, need not entail any such consequence.

Unusual shortness of the tube and the absence of the fimbriæ have been also accounted as causes of sterility; but the former, if associated with a very short ligamentum ovarii, would have no such effect, and could be only accounted a relative deformity when the ovary is placed at an unusual distance from the uterus, so as to be beyond the grasp of the infundibulum; while the latter peculiarity, as already shown, may be merely the result of age.

Peculiarities of Construction. — Several Pavilions on the same Tube. — M. Richard, to whose researches regarding the Fallopian tube reference has been already made, has pointed out a previously unobserved condition of this part. In examining the appendages of the uterus in thirty women, he met with no less than five examples of this singular formation, which he thus describes:

"At a distance varying from several millimetres to 2 or 3 centimetres behind the normal pavilion, are observed upon the course of the tube one or more accessory pavilions, formed like that which terminates the oviduct, of a mucous membrane divided into fimbriæ. When the fringes of this pavilion are floated under water, they are observed to be pierced by an aperture leading into the canal of the tube; and a probe introduced into this orifice may be made to escape either by the ostium abdominale, or by the ostium uterinum, according to the direction in which it is passed. Thus, then, the canal of the tube can, in certain cases, open into the cavity of the peritoneum by several distinct orifices."

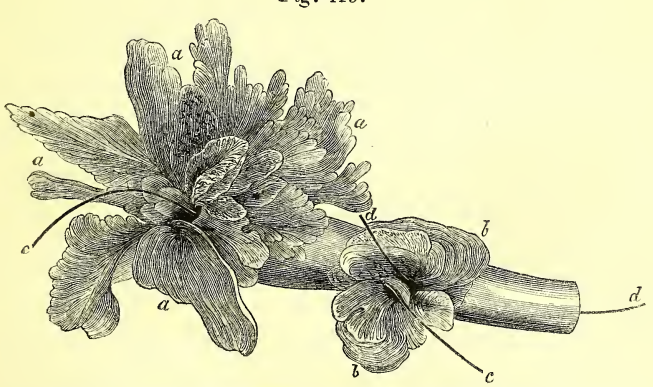
The first of M. Richard's cases occurred in an adult, and is represented in *fig.* 408.

"There is a normal pavilion of somewhat irregular form, and below it, at several millimetres distance, a small opening, surrounded by two small fringes, covered on their inner surface by mucous membrane; while the serous membrane terminates abruptly on their outer surface as in the true pavilion. A probe introduced escapes by one or other orifice indiscriminately."

The second example (*fig.* 418.) occurred in a fœtus at term. The tube of the left side terminates in a single pavilion, but that of the right, besides its terminal pavilion, exhibits also two little secondary pavilions, communicating each by a special orifice with the canal of the tube.

But the most interesting example is that shown in *fig.* 419. from a woman who aborted at the sixth month. The terminal pavilion, represented here of the natural size, exhibits a richness of fringes and folds rarely seen.

Fig. 419.



Extremity of Fallopian tube (human) having two pavilions. (*After Richard.*)

a a, fimbriæ of the terminal or normal pavilion, exhibiting an unusual richness of folds; *b b*, accessory pavilion in the side of the tube, having two distinct orifices separated by a valvular fold; *c c*, a bristle introduced at the terminal pavilion escapes by one of these lateral orifices, but cannot be made to pass out by the other, or to enter the uterus on account of the valve; *d d*, a second bristle introduced from the lower end of the tube escapes by the other orifice of the accessory pavilion, but cannot be made to penetrate as far as the terminal infundibulum.

* Heusinger's Zeitschrift für die organische Physick, II. 2.

† Busch. Das Geschlechtsleben des Weibes, B. IV. p. 348.

Below this large pavilion is another, the fringes of which are large and floating. This abnormal pavilion exhibits two orifices separated from each other by a valve, which, being prolonged into the canal of the tube, interrupts all communication between that part of the canal placed above and that below it. The valve is formed of a fold of mucous membrane. A probe introduced by the abdominal orifice of the tube escapes by one of the two orifices of the supernumerary pavilion, whilst one passed from the uterus appears at the other orifice of the same accessory pavilion.

M. Richard points out a very important influence which these abnormal openings may have upon the functions of the oviduct. An ovum having entered the terminal pavilion, if while endeavouring to gain the uterus it is directed along the wall of the canal which is opposite to the accidental opening, it will reach the uterine cavity; but if, instead of coursing along the wall opposite to the solution of continuity, it descends along this wall itself, then it will almost inevitably escape by this abnormal orifice, and will fall into the peritoneal cavity. Now, if this ovum has not been fertilised, nothing remarkable will ensue upon its escape into the peritoneum; but if the contrary, then it is possible that the fertilised ovum having escaped from the canal which should conduct it to the uterus will give rise to an abdominal pregnancy.

Displacement of the Fallopian Tube. — This is, perhaps, one of those conditions of parts which would be the least likely to be detected during life, and it may on that account have been often overlooked. It is of necessity associated with displacements of certain other organs, whenever such displacements occur; as, for example, with prolapsus inversion and retroversion of the uterus. In extreme prolapsus or procidentia uteri the tubes, along with the ovaries, are carried down and occupy a position on either side of the prolapsed organ, and between it and the walls of the inverted vagina, while in inversion the tubes are contained in the pouch formed by the reversed uterus.* In this latter case the relative situation of all the parts is so altered that the uterine orifices of the Fallopian tubes may be sometimes discovered as forming oblique openings in the upper part of the vagina.† But displacement of the Fallopian tube may occur alone, and constitute a true hernia. Such an occurrence is recorded by M. A. Bérard.‡ In this case the displacement took the form of a crural hernia, which was at first reducible, but after gradually increasing in size it could be no longer reduced. As fluid was distinguishable within the hernial sac a puncture was made, but peritonitis ensued, followed by death; and upon examination it was found that the sac contained nothing but the hypertrophied Fallopian tube.

* See *figs.* 470 and 471.

† Patholog. Museum, Roy. Coll. of Surg. Lond. No. 2654.

‡ Revue Médicale, Mai 1839.

Meissner* has collected three other cases of hernia of the tube, one of which was congenital. These are all instances of inguinal hernia of the tube. In the "Journal für Geburtshelfer†" an instance of displacement of another kind is recorded. The left Fallopian tube had escaped through a rent in the walls of the vagina near the os uteri, and descended as far as the labia, so that the fimbriæ could be easily distinguished during life.

The most common displacements of the Fallopian tubes are those which result from adhesions consequent upon inflammation of their peritoneal coat. Such adhesions constituted by bands or extensive surfaces of false membrane, tie down the tubes to surrounding parts, and in most instances effectually prevent the performance of their proper functions; as where the tubes are adherent to the uterus, the sides of the pelvis, or the bladder or intestines. But the union is most commonly found to have taken place between the extremity of the tube and some part of the surface of the ovary, so that these are inseparably united together (*fig.* 409.), and very frequently in some abnormal position (*fig.* 420.)

Obliteration of the Fallopian Tube. — In advanced life a natural contraction of the tube takes place, and the fimbriæ also diminish and lose their luxuriance of form; but it frequently happens that, independently of these natural changes, and even at an early period of life, the tubes are found nearly or entirely obliterated. Such obliteration may be occasioned by tumefaction of the lining membrane of the tube, or by a collection of inspissated mucus in some part of the canal; or the entire calibre of the tube may be obliterated by cellular formation (atresia tubæ).

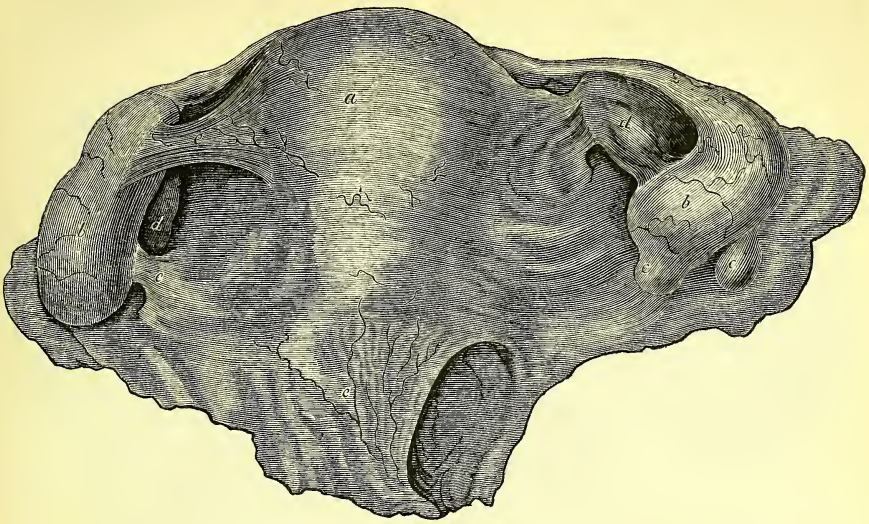
Occasionally calcareous concretions have been found obstructing the tube; and the same result has been produced by growths of a malignant kind.

The occlusion, however, is generally confined to the abdominal end of the tube. In these cases, usually, the fimbriæ are destroyed, the opening into the abdomen is completely closed, and the tube ends in a blunt cul-de-sac. Such a condition of parts is generally associated with an enlarged and tortuous state of the tube, the walls of which are usually thickened, and its canal filled with fluid. In such cases the obliterated end of the tube may remain free and unattached, but it is far more often found united inseparably to the ovary. This junction of the tube with the ovary by artificial adhesion is the most common of all the morbid conditions of the oviduct. It has been supposed by some to be the result of certain libidinous habits and practices; but this conjecture is not supported by any statistical evidence. The explanation given by Rokitansky, that this form of adhesion results usually from an extension of ca-

* Die Frauenzimmer Krankheiten, Leipzig, 1845, Bd. II. p. 203.

† Frankfurt u. Leipzig, 1787.

Fig. 420.



The Fallopian tubes tied down by false membranes to the ovaries and adjacent structures. (*After Hooper.*)
a, uterus; *b*, Fallopian tubes (the infundibula obliterated); *d*, ovaries; *e e*, bands of false membrane.

tarrhal inflammation along the lining membrane of the tube, which, spreading to the fimbriated extremity, gives rise to peritoneal inflammation in the vicinity of the orifice, so that the free terminations of the tube are bound down to the adjacent parts, seems to offer the truest explanation of the nature and origin of this peculiar condition of the parts. See *fig.* 409.

In some of these cases, however, there appears to have been something more than a mere process of exudative inflammation at work. The parts upon examination appear to have become blended by a combined process of absorption of the fimbriæ, and at the same time of firm agglutination of the infundibular base to the surface of the ovary; so that it may be difficult to find any precise line of demarcation between these parts, except that which a difference of colour may furnish.

Hyperæmia or congestion of the tissues of the tube is very commonly observed. It is apparently a normal state during healthy menstruation, but may be regarded as morbid when associated at other times with deep congestion of the uterus and ovaries.

A state of hyperæmia of the tube has been found associated with effusion of blood into its canal, and the escape of a portion of this fluid into the abdomen through the infundibular orifice.

Hyperæmia of the tube occurs as a seminormal condition in cases of tubal pregnancy.

Inflammatory lesions of the tube may present the characteristic conditions of acute or of chronic inflammation. The former is commonly seen in cases of puerperal metro-peritonitis, where the inflammation attacking usually the uterus first has extended to the ovaries and tubes. "The tubes are tumified and infiltrated; their mucous membrane is variously reddened, discoloured, excoriated, softened and everted at the fimbriated extremity. The passage of the tube is dilated, especially at its outer end, and filled with various products, purulent and sanious fluids, and in uterine croup with coagulable lymph, assuming the shape of a tubular concretion, the exudative process having extended from the uterus to the tube." *

But more commonly the traces of inflammation are found in the peritoneal coat, which highly congested and covered by flakes of lymph, partakes in the general inflammatory condition of the adjacent serous surfaces.

In the non-puerperal state, or as a sequel of puerperal affections, inflammation usually takes the form of catarrh or blennorrhœa of the mucous membrane of the tube. The usual evidences of such an affection are, a certain amount of tumefaction of the mucous lining, with thickening of the delicate plicæ covering it, and dark congestion of the capillary vessels. Within the tubal canal are found collections of mucus variously coloured, being sometimes viscid, or occasionally cream-like, yellow and purulent (*fig.* 421.).

The chronic inflammations of the serous coat of the tube, which result in various adhesions of this part to surrounding structures, have been already noticed.

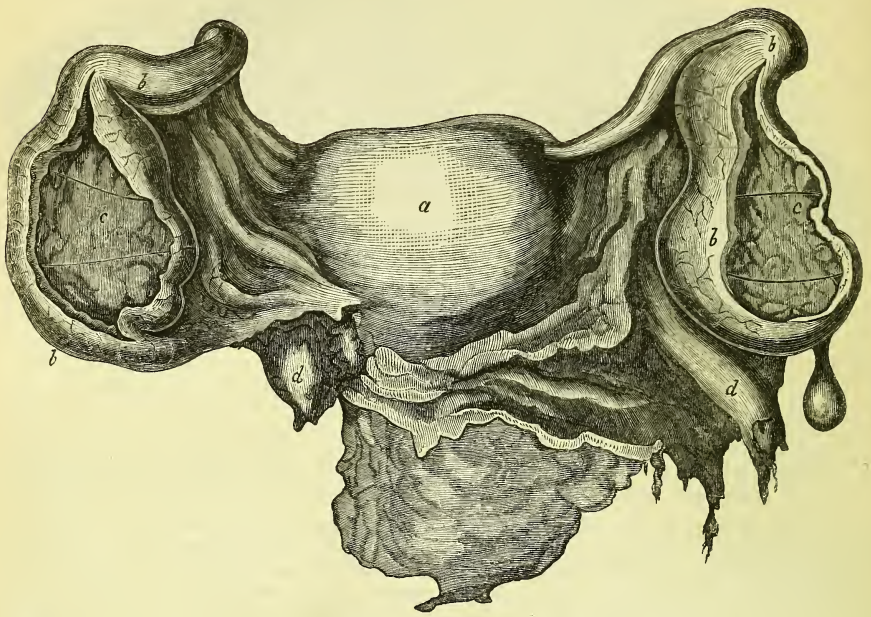
Collections of fluid within the tube result from a combination of two or more of the foregoing conditions. These fluids consist of blood, menstrual fluid, mucus, serum, or pus, and sometimes of these in various states of admixture.

Collections of blood, or of a bloody fluid within the tube, are occasioned by hyperæmia of

* Rokitansky. Patholog. Anat. Vol. II. p. 326.

the tube-walls, whose over-distended capillaries relieve themselves by sanguineous effusion. In such a case, if both the orifices of the tube are patent, the fluid may escape into the uterus, or possibly, by the infundibulum, into the cavity of the abdomen. Of such

Fig. 421.



The Fallopian tubes thickened by inflammation, and distended by collection of fluid. (*After Hooper.*)
a, uterus; *b*, distended tubes; *c*, thickened lining of the same; *d*, round ligament.

effusions there are many examples on record. Or should the abdominal end of the tube be closed in the manner already described, and should the uterine end also be temporarily obstructed, as, for example, by slight congestion of the mucous lining at this point, then the blood, having no outlet, will continue to accumulate within the tube, and a distension of the parietes, more or less considerable, will result.

But all collections of blood within the tube are not necessarily the result of hæmorrhage. The menstrual fluid has been frequenly observed to have accumulated here. And these accumulations may occur under various circumstances. Thus, in the case of imperforate hymen, when the menstrual function has been established for some time, this fluid, after collecting behind the obstructed orifice of the vagina, gradually collects in and distends the walls of the uterus, and ultimately mounts up into the Fallopian tubes, distending them also in the same manner as the uterus.

But atresia of the vagina or uterus, causing such accumulations, is not necessarily congenital, but may be consecutive on adhesive inflammation attacking these parts ; as in the instance of a woman, whose case is related in the American "Journal of Medical Sciences,"* and who, after her second confinement, had an attack of metritis, terminating in cohesion of the uterine walls and consequent occlusion of the cavity of the uterus. Behind this obstruction the menstrual fluid accumulated until the Fallopian tubes became so enormously distended that at length one of them burst, and death resulted from the escape of the blood into the abdominal cavity.

Or lastly, the menstrual fluid may collect in the tube after the manner of the blood in the case just described, where both the orifices of the tube are obstructed. Of such accumulations I have met with many examples; and it is interesting to observe that here, as under many like circumstances, the walls of the tube usually become hypertrophied in proportion to the degree of pressure caused by the accumulations of fluid which they are called upon to resist.

These collections of menstrual fluid within the tube, which I have found to be considerable in some instances, where I have ascertained beyond question that death had taken place during a menstrual period, are instructive, as showing, upon strong probable evidence, that the menstrual fluid is supplied in part by the walls of the Fallopian tube as well as by those of the uterus itself. For I have seen it in cases where both orifices of the tube were obstructed; and therefore in cases where it was not probable that the fluid could have regurgitated from the uterus into the tube.

Collections of serous fluid. Hydrops tubæ Hydrosalpinx.—In catarrhal inflammation of the mucous lining of the tube, whether oc-

* No. XXXV.

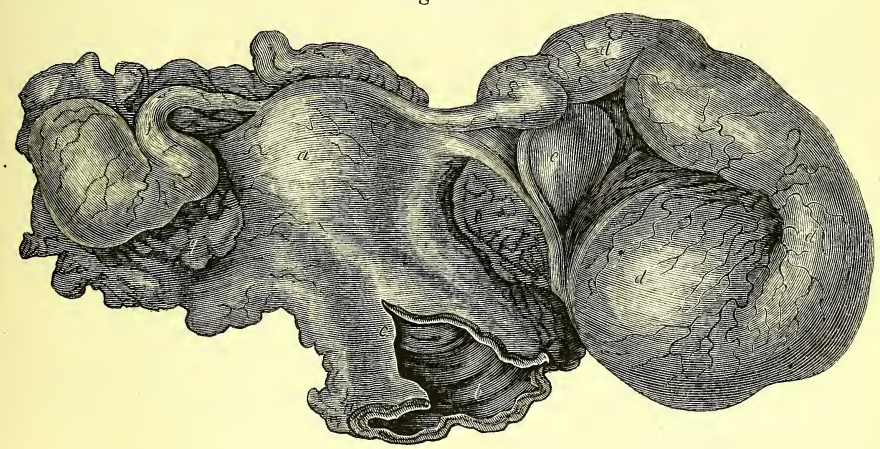
curring in the acute or chronic form, the fluid, secreted more abundantly than in a state of health, may find vent by either or both of the tubal orifices, so long as these remain pervious.

It is probable that in this affection the superabundant fluid flows generally by the lower orifice into the uterus, and so escapes per vaginam, constituting one of the numerous forms of "leucorrhœa." But if both extremities of the tube are closed, then, as in the case of hæmorrhage or menstruation occurring under like circumstances, the fluid collects within the tube and mechanically distends its walls.

The pressure producing this distension, when operating in only a slight degree, causes a nearly equable enlargement of the tube, so that its natural conical shape is still preserved. But as the quantity of fluid increases, the thinner and less resisting portions of the walls, which lie towards the distal extremity, give way more rapidly than those at the proximal end; and the tube, after becoming irregularly tortuous, is at length converted into a series of sacculi, the largest of which, usually of a pyriform shape, occupies the extremity of the tube (*fig.* 422. *d*).

From the irregularity with which different portions of the tube walls dilate under the

Fig. 422.



Distension of the Fallopian tubes, with obliteration of both orifices. (*After Hooper.*)
a, uterus; *b*, vagina; *c*, os uteri; *d* and *f*, Fallopian tubes; *e*, ovary.

pressure of the accumulated fluid, it often happens that several angles are formed by the sudden bending of the parietes, and at these points the tube walls, extending inwards, constitute so many valvular projections which partition the tube into several irregular chambers, communicating together by narrow orifices. Such a condition of parts may be frequently observed upon both sides of the body, as in *fig.* 422., where both tubes are affected in the same manner although in unequal degrees.

When these dilatations have attained to any considerable size the condition of the lining membrane of the tube becomes altered, so that the mucous gradually acquires the character of a serous surface, and the fluids collected within these sacculi present the ordinary condition of the fluids of serous dropsies.

The more simple of these fluids are thin, serous, and nearly colourless, and may be more or less albuminous. Not infrequently, however, they contain flocculi, or are thickened by the admixture of various yellow, brown, or chocolate coloured denser fluids, consisting chiefly of pus and disintegrated blood.

The quantity of fluid does not commonly exceed a few drachms, and in ordinary experience six or eight ounces would be a rather large accumulation. Yet it is certain that sometimes a much more considerable collection has been observed.

Thus in "Bonnet's Sepulchretum Anatomicum*," a case is given in which one of the tubes held thirteen pounds of fluid; and De Haen† mentions an instance in which the hypertrophied tube weighed seven pounds, while the quantity of fluid contained in it amounted to thirty-two pints.

Other cases, of more or less authority, have been recorded, in which the collection of fluid has been estimated at 112, 140 and 150 lbs. But it is exceedingly doubtful if the tube walls are capable of dilating to the extent that would be necessary to support so large an amount of fluid without laceration. For it is very well known that in tubal pregnancy rupture of the tube almost always occurs before the middle period of gestation is reached; and even in those cases where the reports are founded upon post-mortem ex-

* Lib. III. Sect. XXI. Obs. 39.
† Rat. Med. Tom. III. p. 29.

amination it is very possible that a part of the fluid was contained in the ovary, for a concomitant enlargement of both tube and ovary is a very common occurrence, as in the case represented in *fig.* 422.; and on this account no record of any very considerable dropsy of the Fallopian tube should be considered as complete, unless the condition of the corresponding ovary is also mentioned.

Collections of puriform fluid in the tube. — *Abscess of the tube.* — The presence of pus in the Fallopian tube is most frequently associated with suppurative puerperal inflammation of the uterus and its appendages generally. But it may also occur independently of the puerperal state, and as a consequence of catarrhal inflammation of the mucous lining of the tube which may have passed into the suppurative stage. These cases differ from the foregoing, not only in the nature of the contents of the tube, consisting here of pus or of puriform fluids with admixture of other inflammatory products from the lining membrane of the tube; but also in respect of the great tendency which is here observable to the formation of adhesions and the establishment of fistulous openings into adjacent parts, as into the bladder, intestines, or peritoneum, into which cavities these fluids are occasionally discharged.

Cysts containing fluid attached to the tube. — Very commonly there may be observed one or more cysts containing a small quantity of transparent fluid, attached by a narrow peduncle to the tube, and particularly to the distal extremity (*fig.* 368. *e*). The nature of these cysts has been already explained. (See p. 597.) They can only be regarded as morbid when they attain to an unusual size, as in *fig.* 421. They are occasionally found as large as a nut, but they very seldom exceed, and indeed do not often attain even to this size.

Fibrous tumours. — One of the most remarkable points of difference between the morbid conditions of the Fallopian tube and of the uterus respectively is the very great rarity of the occurrence in the former of those fibroid growths, which in the latter constitute its most common abnormal peculiarity. Nothing can mark more distinctly the difference of texture between these two parts than this very characteristic circumstance: since it is now known that the peculiar fibrous tumour of the uterus is formed at the expense of the natural tissues of that part. Occasionally, indeed, small fibrous tumours are found in the parenchyma of the tube, but these never attain to any considerable size. These occasionally undergo calcification, from a deposit of earthy material in their texture, and thus form little masses of stony hardness which project from the walls of the tube, and are covered by its peritoneal coat.

Tubercle is occasionally formed in the Fallopian tube. It occurs there usually in the form of tuberculous infiltration, which, in the opinion of Rokitansky, affects chiefly the mucous membrane of the tube. The occurrence of tubercle here presents nothing remarkable enough to call for further special description.

Cancer of the tube is not a common occurrence. I have never met with it independently of cancer of the ovaries or uterus; but when either of the latter organs are extensively affected, the tubes are also occasionally involved. Upon the malignant diseases of the Fallopian tube most pathological writers are nearly silent; nor has our literature been enriched by any considerable number of special records bearing upon this point in Pathology.

Rupture of the Fallopian tube. — Spontaneous laceration of the walls of the tube occurs sometimes as a result of over-distension, or too great attenuation of its tissues, whereby the parietes are rendered no longer capable of resisting the increasing pressure of the fluids accumulated within. In this way large collections of serous, purulent, or sanguineous fluids are sometimes poured out into the cavity of the abdomen, unless, indeed, by the previous adhesion of the walls of the tube to surrounding parts, the point of rupture is directed to some neighbouring hollow viscus by which the fluids escape externally. But rupture of the tubes will most frequently happen in connexion with the tubal form of extra-uterine gestation, which is next to be described.

Detention and abnormal Development of the Ovum in the Oviduct. Tubal Gestation. Graviditas tubaria. — This constitutes a second species of those aberrant forms of gestation, commonly termed extra-uterine, one of which has been considered under the title of Ovarian Gestation, (p. 586.)

It has been already shown, that one principal office of the Fallopian tube is the conveyance of the ovum from the ovary, or place of its first formation, to the uterus, or seat of its final development; and that the ovum, whilst in transitu, not only becomes impregnated, but also exhibits certain indisputable evidences of commencing development, which, however, has usually advanced only a few stages by the time that the ovum enters the uterine cavity. The tube, therefore, as well as being an oviduct, is also the seat of normal impregnation; whilst, in addition, it serves to protect and possibly, in some slight degree, to add to the material of the ovum, although the actual operation of the tube walls upon the surface of the ovum in this respect must necessarily be very slight in the mammalia, since it so rarely happens that any increase in its size is perceptible from the time of its quitting the ovary to that of its reaching the uterus.

But the impregnated ovum, instead of entering the uterine cavity, may be accidentally detained in the tube, and undergo further development there. The extent to which this development may proceed will depend in a great measure upon the capability of expansion of the tube walls; a circumstance which seems to vary greatly in different individuals, and also in some degree according to the portion of tube which the ovum occupies.

The differences observable in this latter

respect have led to a division of cases of tubal gestation into three varieties, viz. tubo-ovarian, tubal, and interstitial.

In the first variety, *graviditas tubo-ovaria*, the ovum becomes developed in a sac, of which a principal portion appears to be furnished by the hypertrophied walls of the infundibular end of the tube, and the proper tissue of the ovary combined. In the second, *graviditas tubaria*, the developed ovum occupies some part of the canal of the free portion of the oviduct; while in the third, *graviditas interstitialis*, the seat of development of the ovum is that part of the tube which traverses the uterine walls.

In the first, or *tubo-ovarian* variety, the parts supplying the principal foundation of the cyst, which surrounds the fœtus, are in the first instance probably chiefly normal structures; and it is easy to understand how, during the progress of growth of the ovum, when the limit of expansibility of these parts has been reached, there may be superadded to them materials for the extension and further growth of the cyst walls; and in this way are apparently formed these large sacs, or artificial uteri, which have been sometimes observed to surround a fully developed fœtus, and which in the course of their growth have come to include omentum, mesentery, or intestine, and other portions of the abdominal viscera or parietes, by which the sides of the sac become strengthened and enlarged.

As in the case of ovarian gestation formerly described, so in the varieties termed ovario-tubal, it is only when death has taken place during the early stages of formation of these embryo-bearing cysts that the exact nature and relation of the parts originally composing them can be made out. Hence the difficulty of determining, in more advanced stages of gestation, when other parts have been superadded, in what precise situation the development of the ovum was commenced. And hence the probability that some at least of those cases which have been recorded from time to time as examples of the fœtus developed in the cavity of the abdomen, and among the intestines (*graviditas abdominalis*), may have been originally cases of the tubo-ovarian variety, in which the cyst walls, commencing their formation by the artificial union of the expanded termination of the oviduct with a portion of the ovarian parietes, have in the course of their growth come to include many other parts.

The second variety, which includes all cases strictly termed tubal (*graviditas tubaria*), constitutes by far the most common of all the forms of extra-uterine gestation. Here the ovum is developed within some part of the free portion of the tube, whose walls appear, from the examples which most of our museums furnish, to be capable of a very limited degree of expansion in most individuals. Hence, when the ovum has attained to a certain size, and usually by the time that the second or third month of gestation has been reached, rupture of the tubal wall occurs, followed by rapid death from hæmorrhage. And thus the parts are usually obtained for examination in such a state as to leave no room for question regarding the precise seat which the ovum occupies, and the nature of the parts enclosing it. For in these cases of early rupture the tube has contracted no adhesions with surrounding parts, and the walls of the embryo-bearing sac are formed of the parietes of the oviduct alone.

The third variety of tubal gestation, distinguished by M. Breschet under the title of *Graviditas in uteri substantia;* and by Professor Mayer, of Bonn, as *Graviditas interstitialis*, has been made known, particularly by an essay of the former devoted to this subject.*

This variety differs from the last mentioned chiefly in the circumstance, that the seat of development of the ovum is that portion of the canal of the tube which passes through the solid walls of the uterus. Here the sac surrounding the fœtus is formed in a great measure at the expense of the proper uterine tissues, and consequently the parietes of these cysts exhibit under the microscope a very different composition from that which the tube walls show in the second variety.

In interstitial cases the walls of the sac surrounding the ovum sometimes attain in parts a thickness nearly equal to that of the gravid uterus. On section of these portions the appearance which they present is precisely similar to that of the gravid uterus itself. There is here seen precisely the same arrangement of large vascular openings, being the divided canals or sinuses which everywhere permeate the solid walls, in whose composition may be traced the same abundance of smooth muscular fibre, as in the ordinary gravid uterus.

Within such a sac, formed out of the walls of the tube in the first instance, and in the case of this third variety further strengthened by the addition of a large quantity of tissue derived from the uterus, the ovum lies, presenting its ordinary character of an external chorion and inner amnion; the fœtus or embryo itself, according to the period of gestation, being perfectly formed. The walls of the sac, being in this case usually much stronger than when the ovum lies nearer to the distal end of the tube, resist pressure for a longer time, and consequently the fœtus may attain a greater growth.

One of the most interesting questions connected with this subject is, whether a decidua is here formed. Schrœder van der Kolk, in his recent most valuable work on the structure of the Placenta†, answers the inquiry in the affirmative, in contradiction to the statement of Virchow‡, by whom it is asserted that in the case of tubal gestation no decidua

* Mémoire sur une nouvelle espèce de grossesse extra-utérine. Par M. Breschet.

† Waarnemingen over het Maaksel van de Menschelijke Placenta. Amsterdam, 1851, p. 88. *et seq.*

‡ Virchow, ueber die Puerperal Krankheiten Verhand. der Ges. für Geburtshelfe. Berlin, 1848, B. III. s. 180.

is to be found in the tube. According to Schrœder, a decidua is here formed in tubal pregnancy, notwithstanding that in the walls of the tube glandulæ utriculares are entirely wanting. The villi are here embedded in little hollows of the decidua, upon whose walls the blood vessels terminate in open mouths, and thus the blood is poured out into the placenta. The decidua is, indeed, in this case firmer, and does not exhibit so many valvular openings as are present in an ordinary placenta; probably from the absence of the utricular glands. In this case, also, an epithelial layer derived from the decidua covers the villi, and serves at the same time as a means of junction between the parts.*

Associated usually with the abnormal development of the ovum in the oviduct is the formation of a decidua in the uterus, the nature of which structure will be considered in a subsequent portion of this article (pp. 635. 652).

And here it naturally occurs to inquire into the probable causes of the development of the ovum in a situation so unfavourable to its further and complete evolution. Since, notwithstanding the wonderful power of adaptation which is in these cases exhibited by the parts immediately surrounding and containing the ovum, it is plain that the oviduct however altered, yet, on account of its peculiar form and texture, can but inadequately supply the offices of a uterus. It can serve but imperfectly for the nutrition and protection of the fœtus, and not at all for its expulsion, even should the latter reach the term of its dependent or intra-uterine life.

One of the most remarkable circumstances relating to this curious subject, is the fact first noticed, I believe, by Dr. Oldham, that in a large number of cases of tubal gestation, the corpus luteum, correspondiug with the ovum impregnated, is found in the ovary of the opposite side to that of the tube in which the ovum is developed. Thus if the left Fallopian tube contains the ovum, the right ovary will often display the corpus luteum of a corresponding date, and *vice versâ*. Not being at first aware of Dr. Oldham's observation, I had myself noticed the same circumstance in repeated instances, and had arrived at the same conclusion as he has done in explanation of it, namely, that at the time of the ovum quitting the ovary, the tube of the one side embraced the opposite ovary, and conducted away the ovum, which being impregnated in the ordinary way, and then being delayed at the angle formed by the bending of the tube, has its further progress obstructed at that point until it attains too great a size to admit of its subsequently passing the lower orifice and entering the cavity of the uterus.

If it be objected that this explanation is not satisfactory, because it assumes the apparent improbability of the fimbriated extremity of one Fallopian tube being able to grasp the opposite ovary, then I can point to a preparation in the Cambridge University Anatomical Museum *, in which both the Fallopian tubes grasp the same ovary to which their extremities are affixed by morbid adhesion.

Another and very different explanation of this remarkable circumstance of the impregnated ovum and corresponding corpus luteum being found on opposite sides, has been given by Dr. Tyler Smith †, who believes that the ovum, after descending the Fallopian tube of one side, traverses the upper part of the uterine cavity, and ascends the opposite oviduct, where it becomes developed. I might also furnish the advocates of this doctrine with an argument founded upon a most interesting and curious observation of Bischoff, which appears to have been overlooked, but which would at first sight seem to support this view. Bischoff, in his essay on the development of the ovum in the dog and rabbit, frequently noticed a remarkable apportioning of the ova between the two cornua of the uterus, so as to equalise their number on the two sides, when these had been originally unequal, as shown by the number of corpora lutea found in the ovaries. Thus, in the case of a bitch whose right ovary exhibited one, and the left ovary five corpora lutea, each half of the uterus contained three ova, so that two of the ova must have travelled across from the right to the left side. But it must be observed, that in the cases recorded by Bischoff the ova never ascended the Fallopian tube, but only travelled from one cornu of the uterus to the other.

When, therefore, we take into consideration the great difference between the solid uterus of man and the intestine-like organ of the mammalia, on which these observations were made, there appears to be great difficulty in supposing that the ovum could after once arriving at the uterus again enter an oviduct, especially when also it is remembered that while the conical form of the Fallopian tube, whose smallest aperture is towards the uterus, constitutes a provision for ensuring the arrival of the ovum there, this arrangement would greatly diminish the possibility of a retrograde movement taking place in the human subject, if indeed it would not altogether prevent it.

But to those cases of tubal gestation in which the corpus luteum is found in the corresponding ovary, neither of these explanations would apply. Here it is only necessary to suppose, that either the developmental changes already described as occurring normally to the ovum in the tube, have proceeded more rapidly than usual, or else, that the ovum, having been accidentally delayed for a longer time than ordinary in transitu, had acquired too great a magnitude to admit of its passage by the uterine orifice, even admitting, as some have supposed, that this orifice may, to a certain

* Upon this point I do not here give any observations of my own, as I am preparing these for publication in another form.

* No. 722.

† Lancet, No. xv. vol. i. 1856.

extent, dilate, for the purpose of allowing the ovum to pass, just as the os uteri dilates at the time of labour.

UTERUS.

Normal Anatomy.

(Syn. *Womb*, *Mother*, Eng.; Μήτρα, Ὑστερα, Δελφύς, Gr.; *Uterus*, *Matrix*, Lat.; *Utero*, Ital.; *Matrice*, Fr.; *Bärmutter*, *Gebärmutter*, *Fruchthälter*, Germ.; *Baarmoeder*, *Lijfmoeder*, Dutch.)

The uterus is that segment of the generative track which lies between the lower extremities of the Fallopian tabes and the fornix or upper end of the vagina. In man it is normally formed by the complete coalescence of the two uterine cornua, which in most of the mammalia remain more or less distinct constituting the bicorned or divided uterus. These, in man and the quadrumana, unite to form a single symmetrical organ, serving for the passage of the seminal fluid, and for the reception, protection, nutrition, and final expulsion of the mature ovum.

The uterus is not altogether peculiar to the female. Like the mammary gland, it has its representative in the male, though only in a rudimental state. The existence of such a rudimentary organ is more easily shown in the male of many mammalian animals than in man, in whom, perhaps, it is the least conspicuous, and where its presence, as a type of structure, can only be proved by a close study of homologies, and by the aid of those occasional exemplifications of the true relations of this part which the comparatively rare occurrence of hermaphrodite forms affords.

Situation and position.—The unimpregnated uterus is situated entirely within the pelvis, where it lies deep among the other pelvic contents, with many of which it is in immediate relation; the bladder lying anteriorly, the rectum posteriorly, the ovaries and Fallopian tubes laterally, the small intestines superiorly, and the vagina and perineum inferiorly with regard to it. These several parts, aided by the broad and round ligaments, serve to support the uterus and maintain it in its natural position. But this position will of necessity vary according to the condition of the neighbouring organs, and in some degree also with the varying postures of the body.

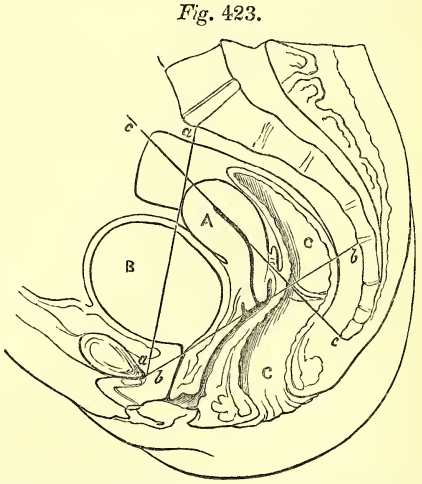
The nature and degree of the variations in regard to situation and position of which the uterus is susceptible will be more easily understood after the ligaments and other connections by which these movements are restrained have been described. At present it will be only necessary to observe that the motions of the uterus are restricted chiefly to three directions. First, the broad ligaments, which maintain the organ nearly in the median line, permit by their laxity a slight deviation towards either side. Secondly, a certain amount of ascent and descent is allowed by the structures which attach the uterus to the lower part of the pelvis. But the former of these movements will be limited by the utero-sacral ligaments, and the weight or pressure of the superincumbent viscera; and the latter also especially by the same ligaments, and to a certain extent by the support derived from the posterior wall of the vagina and the parts which close the pelvis below. Thirdly, the uterus enjoys a certain range of motion in the direction of a line drawn from pubes to sacrum in order to accommodate it to the state of fulness or emptiness of the adjacent viscera. For when the bladder is full and the rectum empty, the uterus will be carried nearer to the sacrum; and conversely, with an empty bladder and a distended rectum, the position of the uterus will be proportionately nearer to the pubes; and these alterations of position will be constantly and daily repeated.

But an equal degree of mobility does not belong to every part of the uterus; for while the movement of the cervix is limited by the attachment of the vagina and utero-sacral ligaments, the fundus is left entirely free to follow the alternate fillings and emptyings of the bladder. Thus a movement of nutation will result, the fundus uteri approaching the pubes and sacrum alternately; and this is probably the greatest range of motion of which any portion of the uterus is normally susceptible.

But allowing for these variations, there will still be an average position which the uterus occupies in the pelvis, and this may be assumed to occur at the time when the bladder and rectum are both moderately distended.

Under these circumstances, the position of the uterus relatively to surrounding parts will be in accordance with the accompanying sectional diagram (*fig.* 423.), representing the pelvic contents. Here A represents the uterus, B the bladder, and C the rectum, both of the latter being moderately distended.

Fig. 423.



Sectional diagram to show the normal position of the uterus in the pelvis.

At such a time the uterus, supported between the folds of the broad ligament, which constitutes a moveable dissepiment, dividing the pelvis transversely into two unequal parts, and sustained by the parts attached to it around and below, lies with its fundus directed obliquely upwards and forwards, while the cervix or neck looks downwards, and very slightly backwards towards the orifice of the rectum. The relative heights of these several parts are determined by two lines: the one, *a*—*a*, drawn from the lower border of the symphysis pubis to the promontory of the sacrum; the other, *b*—*b*, from the same point to the lower margin of the fourth sacral vertebra. Upon the latter the cervix will rest at a point near the centre of the line. The direction of the uterine body will be more conveniently shown by a third line, *c*—*c*, drawn through its axis. This line, if produced, will pass out of the pelvis upwards at a distance of $\frac{3}{4}''$ in front of the sacral promontory; and downwards, after traversing the posterior wall of the cervix, it will pass out about the centre of that wall, and impinge upon the extremity of the coccyx. The lower portion or cervix of the uterus being curved upon the body in the manner hereafter described, the direction of its canal will be downwards, and will be represented by a line drawn nearly perpendicular to the horizon.

Form. — The uterus belongs to the class of hollow muscles, with which it is associated on account of its cavity and the muscular character of its proper parietes. In many of the mammalia, the elongated form and general arrangement of the tissues gives to the uterus a resemblance to an intestine; while in man and the quadrumana, in whom it possesses a considerable degree of firmness and solidity, the shape more nearly resembles that of the urinary bladder.

The uterus has been compared to various objects, such as a flask, a little gourd or calabash, a pear, or a truncated cone. There is enough of similarity to these several objects, to excuse the comparison, yet the resemblance is not sufficiently close to render any of them an exact representative of that body; but perhaps the flattened pear conveys the best idea of the uterine figure, although the pyriform outline is somewhat broken by the attachment to its lateral borders of the parts usually termed appendages (*fig.* 368.). These should be, therefore, removed in order to display the proper boundaries of the organ (*fig.* 424. and 431.).

Dimensions. — The uterus does not attain to its full development until after the establishment of puberty. Previous to this period it remains but little altered from its infantine condition; but as the period of puberty approaches, and about the time when the mammæ, which have also until then retained their infantine state, begin to enlarge, the uterus rapidly increases in bulk and weight. It then soon reaches the size which, if unemployed, it maintains through the rest of life, only wasting, and becoming somewhat altered in figure by absorption of its tissues, as age advances; or, if employed in the process of reproduction, then undergoing a degree of temporary enlargement unparalleled by any other growth of structure in man, and subsequently returning, in part, though never entirely, to its former state.

The following are the average dimensions of the virgin or nulliparous uterus. The entire length from the centre of the fundus (*fig.* 424 *a*), to that of the anterior lip *b*, which gives the longest diameter, is $2'', 3'''$—$7'''$.

Of this one half usually belongs to the body, and the remainder to the neck or cervix; but the proportional length of either of these parts may exceed the other by $1'''$—$2'''$.

The greatest breadth of the organ is found opposite to the point of attachment of the Fallopian tubes. Here the transverse diameter is $1'', 3'''$—; at the point of junction of the cervix with the body $10'''$; about the centre of the cervix $12'''$; at the extremity of the cervix, opposite to the point of junction with the vaginal walls, $11'''$—$12'''$.

The antero-posterior diameter of the uterus is greatest about the centre of the body, where it measures in the nulliparous organ $11'''$—$12'''$.

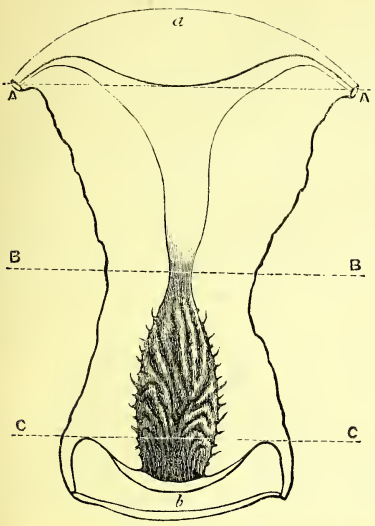
Weight. — The weight of the adult virgin uterus, deprived of the appendages, is 9—12 drachms.

Regional divisions. — The uterus is divided primarily into a body and neck or cervix. Each of these is again subdivided, the upper portion of the body being termed the fundus, while the lower or terminal part of the neck is distinguished as its vaginal portion. These divisions, though to a certain extent artificial, are necessary, not only to facilitate description, but also to distinguish parts which exhibit great and important differences both of structure and function. So great, indeed, is the amount of structural and functional difference between the body and neck of the womb, as almost to justify these being regarded as two distinct organs.

The *fundus* is that portion of the body of the uterus which lies above an imaginary line, (*fig.* 424. A A,) drawn transversely across the organ from the point of attachment of one Fallopian tube to that of the opposite side. This portion of the uterus is of a very dense and firm texture. It is very slightly convex in the virgin state, but becomes considerably arched and expanded during pregnancy, when it forms, as it were, a vaulted roof to the organ. After parturition the fundus does not regain its former figure, but retains more or less of the rounded form which constitutes one of the points of difference between the nulliparous and multiparous organ. The fundus is that part of the uterus which, from its concealed position within the pelvis in the unimpregnated healthy state, is the least capable of being examined during life. It is of all parts of the uterus that which is the least subject to destructive disorganisation by malignant growths, frequently remaining un-

altered in texture after the whole of the cervix has been destroyed by carcinomatous ulceration. On the other hand it is the part

Fig. 424.



Section showing the regional divisions of the uterus. (Outlined ad Nat.)

from which polypi, that are not cervical in their origin, most frequently arise; and it is very commonly the seat of those large hypertrophic growths of the uterine tissue, which are usually termed fibrous tumours. The fundus is also the part to which the upper portion of the placenta is most frequently attached.

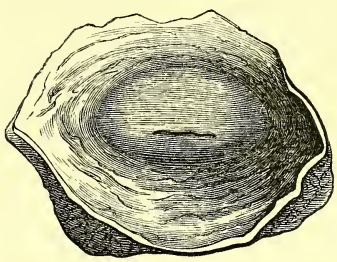
The body is included between the line above indicated, and another, B B, drawn through the narrowest part of the organ, or that point at which the tapering lateral walls of the uterus approximate in the greatest degree before they again diverge to pass into the cervix. The body of the uterus constitutes its principal portion. It is that part which, more than any other, expands to invest the ovum. It is freely supplied with blood-vessels, which, entering by the lateral border, ramify abundantly through the anterior and posterior walls. These walls are usually half an inch in thickness. They are separated from each other by a scarcely appreciable cavity, to be hereafter described, lying between the inner surfaces of the parietes. The extreme narrowness of this cavity is shown in *figs.* 427 — 430., which represent transverse sections of the uterine body, at various points between the fundus and internal os.

The cervix, or neck, (*fig.* 424. B—C), is a cylindriform prolongation of the uterine body, to which it serves as an excretory conduit. It is composed in part of tissues similar to those of the body, but the arrangement of these is materially different. The walls of the cervix measure 4‴ in average thickness. Their inner surfaces are not in immediate contact like those of the uterine body; but diverge slightly to enclose a flattened spindle-shaped cavity, termed the canal or cavity of the cervix.

The situation of the widest or central part of this canal is indicated by an external lateral bulging of the walls of the uterine neck. The posterior part of the cervix receives a loose investment of peritoneum; but the whole or the greater portion of its anterior wall, as well as the lower or vaginal portion, is uninvested by that membrane.

The vaginal portion.—The lower extremity of the cervix (*fig.* 424. below, C C) projects

Fig. 425.



Os uteri, and vaginal portion of the cervix. Virgin. (Ad Nat.)

into the vagina in the form of a flattened cone. The length of this conical projection is about 4‴. It is of unequal diameter. Transversely it measures 11‴—12‴ at the base, and 6‴—7‴ at the apex; but its antero-posterior diameters are only 7‴—8‴ at the base, and 5‴ at the apex; so that a section of this part will represent an ellipse. Around the base of this conical portion the walls of the upper end of the vagina are attached. The vaginal attachment constitutes the line of demarcation between the lower or vaginal and the upper or supra-vaginal division of the cervix. It should be observed that the end of the cervix does not lie, as is commonly supposed, exactly at the extremity of the vaginal canal, but that it projects into its upper wall, so that the upper vaginal wall is shorter than the lower by the whole antero-posterior diameter of the cervix (*fig.* 426. and 433.). This explains the difficulty which is sometimes experienced in bringing the cervix into view when a tubular speculum is employed, the sides of which are all of equal length. There can be no doubt that this peculiar position of the extremity of the cervix prevents the part from suffering injury in coitu, because the impulse of the intromittent organ is received upon the end of the vagina, and is distributed upon the adjacent parts, through the intervention especially of the utero-sacral ligaments. See further, p. 689.

At the apex of this conical mamelon is observed a transverse fissure 3‴—4‴ in length. This is the lower or terminal orifice of the cervical canal, the os externum uteri, *fig.* 425., as distinguished from the os inter-

num, *fig.* 431, *i*, which marks the commencement of that canal. The os externum is bordered in front and behind by two smooth lips, whose commissure on either side forms the lateral boundaries of the orifice. The lips constitute the terminations of the anterior and posterior cervical walls respectively. They are accordingly distinguished as the anterior and posterior lips of the os uteri. Their position and form are most conveniently shown in a vertical section of the part (*fig.* 426. and 433.). The anterior lip is the smaller; it projects but slightly into the vagina, but it lies at a lower level than the posterior one, on account both of the greater length of the anterior wall of the uterus, and also from the inclination of the upper part of the organ forwards. In an antero-posterior view, the anterior serves to conceal the posterior lip, which lies higher in the pelvis, both from the comparative shortness of the posterior uterine wall, and also from the tilting forward of the entire organ; nevertheless the posterior lip makes a greater projection into the vagina, because the walls of that canal are reflected off at a higher point upon the cervix posteriorly than anteriorly. This unequal form of the two lips doubtless gave origin to the term os tincæ, by which the older anatomists designated the part.

In no portion of the uterus is the difference between the nulliparous and multiparous organ so marked as in the vaginal portion of the cervix. After the birth of many children, this part becomes much enlarged, soft, flaccid, and of irregular form, with notched margins; but in the virgin it has uniformly the smooth, even, conical figure just described, while its consistence is nearly that of soft cartilage.

External surface.—The uterus, being a hollow or cavitary organ, possesses both an *external* and an *internal* surface. The external surface exhibits two faces, anterior and posterior; three borders, one superior and two lateral; and three angles, two superior and one inferior.

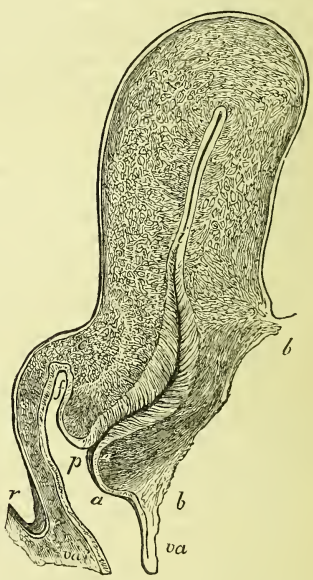
The anterior face is smooth, and gently convex in the transverse direction (*figs.* 427—430.), but often slightly curved from above downwards (*fig.* 426.). It is covered by peritoneum in all but its lower part, where this membrane is reflected off to give a covering to the bladder at a distance of not less than one fourth of the entire length of the uterus from its lower extremity. The posterior face is more decidedly convex; and in some subjects, especially in multiparæ, it exhibits a marked prominence along the median line, from which the walls proceed outwardly in two nearly level planes. These, meeting the less convex anterior walls at the lateral border, give to a transverse section of such an organ an outline more or less triangular (*fig.* 428.). The posterior face also receives an investment of peritoneum. The membrane here, after covering the entire posterior surface of the uterus, usually dips down to cap the upper extremity of the vagina. (*Fig.* 426. *c—r.*)

The superior uterine border is moderately convex; it extends from the point of entrance of one Fallopian tube to that of the other (*fig.* 431. *f f*). This border is entirely covered by peritoneum. The two lateral borders extend from the point of entrance of either Fallopian tube downwards to the lower extremity of the uterine neck, as far as the margins of the os uteri. These borders are flexuous, being convex above, concave towards and below the centre of the organ, again slightly convex about the middle of the cervix, and finally terminating at the os uteri, after having their continuity interrupted by the circular attachment of the vagina near the termination of the uterine neck. The lateral borders are uninvested by peritoneum; for it is here that the two laminæ of that membrane, which form the broad ligament, meet to inclose the uterus; and by these two lateral borders, the blood-vessels and nerves supplying the organ enter it without penetrating its outer or serous coat (*fig.* 428.).

The two superior angles are formed at the points of entrance of the Fallopian tubes. The inferior angle is occupied by the vaginal portion of the cervix and the os uteri.

Internal surface and cavities of the body and cervix. — It has been stated that the walls of the uterine body are in nearly close apposition internally, leaving only a small intermediate space, termed the cavity of the uterus, which is easily displayed by cutting through

Fig. 426.



Vertical section of the uterus parallel with its lateral borders.

a, anterior, and *p*, posterior, lip of cervix; *i*, internal os uteri; *v a*, vagina; *f*, fornix; *c*, loose connective tissue immediately above the fornix; *r*, point of posterior reflection of the peritoneum on to the rectum, forming the retro-uterine pouch or space of Douglas; *b b*, line of attachment of the cervix to the bladder. The peritoneum ceases at the upper *b*, in front. (*Ad Nat.*)

the substance of the organ. No just conception, however, of the real form or capacity of this interspace can be obtained by examining it with the aid of sections made in one direction only.

In order to obtain a correct notion of the form and extent of this cavity, it is desirable first to make a longitudinal section through the centre of the entire organ parallel with its lateral borders. The cavity or interspace is then indicated by a line running from below upwards, and terminating within half an inch of the fundus (*fig.* 426.).

The upper half of this line indicates the cavity of the *uterus;* the lower half, that of the *cervix*. The latter alone exhibits a true cavity; for here the parietes of the cervix are observed to diverge slightly, so as to leave a spindle-shaped canal traversing the whole length of the uterine neck (*fig.* 431. *c c*).

A second view is obtained by cutting completely through the uterus in the direction of its transverse diameter, and parallel with its extremities. If the entire organ be cut up into many such segments (*fig.* 427—430.), itis then seen, from the length of the central line, that the cavity varies in breadth, its widest part being in the segment which includes the extremities of the Fallopian tubes; whilst from this point downwards the line diminishes in length, until at the narrowest portion of the uterus, or that representing the commencement of the cervix, it measures only $1\frac{1}{2}'''$—$3'''$ in diameter.

But the most complete view of the interior of the uterus is obtained by a section carried through the centre of the organ, dividing it midway between its anterior and posterior walls. The entire cavity which is thus exhibited at one view is seen to be of a triangular form; its boundaries being formed superiorly by the fundus, and on either side by the two lateral borders, whilst in each angle is observed an aperture. The two superior openings are the lower orifices of the Fallopian tubes. The inferior opening leading to the cervical canal constitutes the os uteri internum (*fig.* 431. *i*).

Fig. 427.

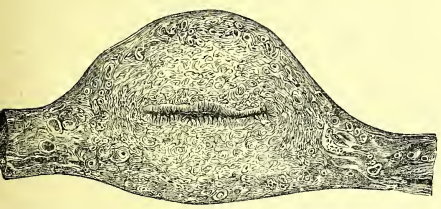


Fig. 428.

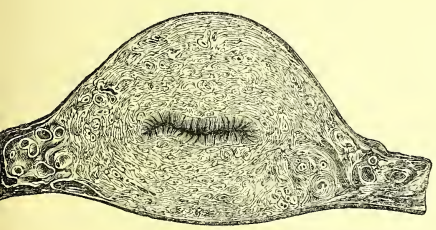


Fig. 429.

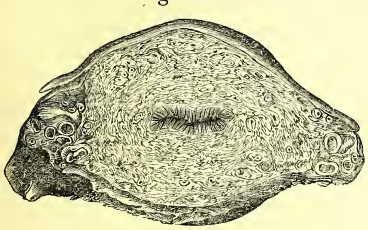
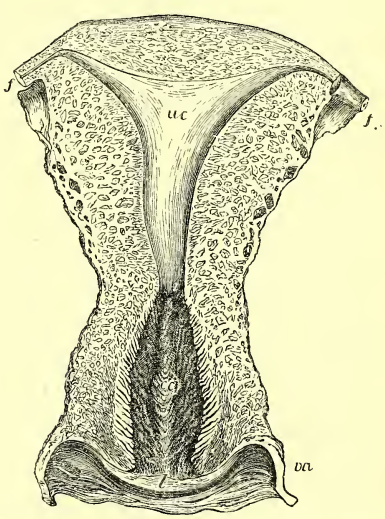


Fig. 430.

Series of horizontal sections of the uterus.

Fig. 427., just above the entrance of the Fallopian tubes. *Fig.* 428., in the centre of the cavity. *Fig.* 429., close to the internal os uteri. *Fig.* 430., the centre of the cervical canal. The upper or more convex border marks the posterior surface in each section. (*Ad Nat.*)

Fig. 431.



Vertical section of nulliparous uterus parallel with its anterior and posterior walls.

u c, uterine cavity; *c c*, cervical cavity or canal; *i*, internal os uteri; *e*, external os uteri; *f, f*, Fallopian tubes; *v a*, vagina. (*Ad Nat.*)

Since the cavity in the interior of the uterine body has a triangular form, whilst externally the shape of the organ is more or less pyriform, it is evident that the parietes of this "hollow muscle" cannot have everywhere an equal thickness, for otherwise the form of the cavity would correspond with

that of the external surface. But whilst the anterior and posterior walls exhibit an average and nearly uniform thickness of about 6‴, that of the lateral boundaries and of the fundus varies from 6‴ to 1‴. Hence the section of this cavity represented in *fig.* 426., which exhibits the organ as divided from before backwards, is described by a right line; whilst the section (*fig.* 431.) shows the cavity as bounded by three curves, the degree of curvature varying in different subjects, and being generally supposed to be always greatest and most marked in women who have never borne children.

This point has been much dwelt upon as serving to distinguish the nulliparous from the multiparous uterus. I have reason to think, however, that this observation has been again and again repeated without confirmation by an appeal to facts. For although the sides of the virgin uterus are often strongly incurved, yet in some uteri in my possession from young subjects who had not borne children, the walls of the cavity are nearly straight, and this is the form which they have in the fœtus (*fig.* 442.), and in undeveloped uteri (*fig.* 465.); whilst in other specimens, taken from women who had borne many children, the sides and fundus may be incurved in various degrees. Much will depend upon the mode in which the sections are made; for unless, in dividing the organ, the knife has passed exactly through the median line, a portion of either the anterior or posterior wall will be included in the section, and the apparent form of the cavity will be materially modified thereby.

Thus the uterine cavity in the unimpregnated state is nothing more than the narrow interspace between the flattened walls which are normally either in immediate contact, or are separated from each other by only a small quantity of mucus. The triangular form results from the confluence of three ducts or channels; viz., the two oviducts above, and the cervical canal below. The tubal canals, having passed through the substance of the uterus, expand trumpet-like into the uterine cavity, whilst in the same way the cervical canal traced upwards is prolonged, though more gradually, into the same cavity. But the perpendicular diameter of the uterus being always greater than the transverse, the form of the cavity, in so far as it is triangular, represents not an equilateral, but an isosceles triangle with incurved sides (*fig.* 431.).

By reference to these particulars regarding the form of the interspace between the uterine walls, we are enabled to explain many phenomena relating to the first entrance of the ovum into the uterus, and its mode of detention there, before it has become organically united to the uterine walls.

The cavity of the uterus is lined by a mucous membrane, the peculiarities of which will be afterwards more fully described. This membrane appears to the unaided eye nearly smooth, and is usually of a pale pink colour, except in those cases where death has occurred during menstruation, when it is of a deep red hue, and more or less plainly vascular. A moderate amplifying power, however, suffices to show that the mucous membrane is not smooth, but is perforated everywhere by minute apertures, which are the orifices of numerous ramified canals or follicles occupying the substance of the mucous membrane, and lying for the most part in a direction perpendicular to the surface upon which they terminate. A few folds are occasionally perceptible in the mucous membrane, these being seen chiefly in the neighbourhood of the tubal orifices.

The apertures by which the Fallopian tubes enter the upper angles of the uterus are so small as only to admit of the passage of a fine bristle (*fig.* 406.). That by which the cavity of the body communicates at its inferior angle with the canal of the cervix has an average diameter of 1½‴—3‴. This orifice is the os uteri internum (*fig.* 431. *i*).

The following are the dimensions of the uterine cavity:—length 11‴—12‴; breadth between the points of entrance of the Fallopian tubes 11‴—12‴; at the centre of the cavity 4‴; at the os internum 1½‴—3‴.

The cavity of the cervix consists of a flattened fusiform canal running through the centre of the uterine neck. The widest portion occurs about the middle, where the canal measures transversely 3½‴—6‴ (*fig.* 431. *c c*), whilst towards either extremity the parietes gradually approximate so as to leave a narrow aperture at each end; the superior aperture being the orifice already described as the os uteri internum, the dimensions of which have been given;—the inferior being the os externum, or os tincæ, which measures 3‴—4‴ in transverse diameter. The antero-posterior diameter of the canal at its widest part is not more than 1½‴—2‴. The entire length of the cervical cavity is 12‴—13‴.

The mucous membrane lining this cavity is probably not greatly inferior in extent to that of the uterine body. But on account of the smaller space in which it is contained, instead of forming an even layer, the membrane is here thrown into numerous folds or plicæ, having intermediate furrows, often traversed by lesser plicæ, which extend the secreting surface, and furnish a more considerable seat for those numerous mucous crypts which abound upon almost every portion of this structure.

The forms which the cervical folds or plicæ assume are sufficiently remarkable to have attracted the attention of anatomists at all periods. They are, however, so variable, that if twenty specimens be compared together, scarcely two will be found to present precisely the same arrangement. On this account it is difficult to furnish any description of them which shall be universally applicable.

Nevertheless, two forms appear to me to be more prevalent than others. In one a single prominent raphé occupies the centre of each wall of the cervix. (*Fig.* 431. *c c.*) Com-

mencing sometimes at a distance of $1\frac{1}{2}'''$—$3'''$ above the margin of the uterine lip and extending upwards either centrally or to one side of the median line, and reaching as far as the internal os, it terminates here in a bulbous expansion, or branches out into numerous small ramifications. From either side of this median perpendicular fold are given off lateral plicæ, varying in number, but being usually not less than 6—9. These soon bifurcate once or twice, so that the number of folds will vary considerably, according as they are counted immediately at, or at some distance from, their line of junction in the central raphé. The uppermost pair of lateral plicæ, or those next to the raphé, often exhibit the same bulbous extremity; and these together fill the upper or narrowest portion of the cervical canal. Lower down, where the canal becomes wider, the lateral plicæ spread out on either side of the central raphé, the upper ones in an oblique, the middle and lower ones in a more horizontal direction. These soon bifurcate, and form a series of oblique, horizontal, or arched laminæ, whose arrangement varies much according to the fulness of the folds, the depth of the furrows between them, and the distance by which the laminæ are separated. If the latter are prominent and very closely set, their margins may overlie each other, like the branchial laminæ of a fish, so that no intermediate furrows are perceptible; or the folds, not being very prominent, may merely lie in apposition, leaving no visible interspace until they are drawn asunder; but when the plicæ are less full and prominent a furrow is perceptible between each. These furrows of necessity take the same direction as the plicæ by which they are bounded.

In another common form which the plicæ assume, the general lines of folds and intermediate furrows take a more vertical direction, so that sometimes as many as six or eight of the more central laminæ may be traced running down side by side to the very margin of the cervical lips (*fig.* 424.). Here often the two most central folds appear to run up from one end to the other of the cervical canal; but still commonly one of these is more fully developed than the rest; its upper bulbous extremity occupying the position in the narrow portion of the cervical canal already described, while its lateral divisions being more numerous than those of the plicæ next adjoining, it takes the office of a raphé, though its position may be, as it often is, more or less eccentric.

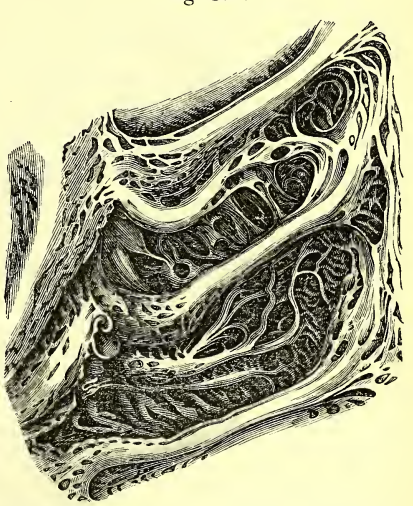
On either side of this principal fold the lateral plicæ arrange themselves, inclining more outwardly in proportion as they occupy a still lower place in the cervix. But in these cases the curves of the lateral plicæ are often very abrupt — the laminæ rising obliquely upwards, and then making a sudden downward bend like the ends of the leaves of a lily. This arrangement of the plicæ I think I have more often observed upon the posterior wall of the cervix, where the laminæ are usually thicker and bolder than upon the anterior wall, upon which the arrangement first described appears more commonly to prevail. But so various are the forms which the principal folds of the mucous lining of the cervix assume, that it is not possible to fix upon any one instance whose description, however minute and accurate, will serve as a strict example of the rest.

The more perpendicular the arrangement of the plicæ, the nearer is the approach to that form which is most commonly found in the terminal part, or neck of the uterus, in the mammalia generally, where the folds almost invariably take the direction of the long axis of the canal, reminding us of the arrangement of the plicæ in the Fallopian tube already described.

After repeated pregnancies these plicæ become much thickened and the folds more prominent, while their extremities exhibit a swollen and bulbous appearance resembling leaflets attached to the branch of a tree. Hence, apparently, the origin of the old term *arbor vitæ*, by which this structure was commonly designated; while to the more closely arranged plicæ, springing from a central shaft or raphé, the term *penniform rugæ* is more strictly applicable; and to those cases in which several parallel folds, after ascending obliquely, form a series of lateral arches, or suddenly bend over and then downwards, the title of *plicæ palmatæ*, or as some employ it, *palmæ plicatæ*, seems more appropriate.

Thus upon both walls of the uterine cervix the mucous membrane, being of greater extent than the surfaces which it lines, is gathered

Fig. 432.



*Portion of cervix uteri. Enlarged 9 diameters. (After Tyler Smith, and Hassall.)**

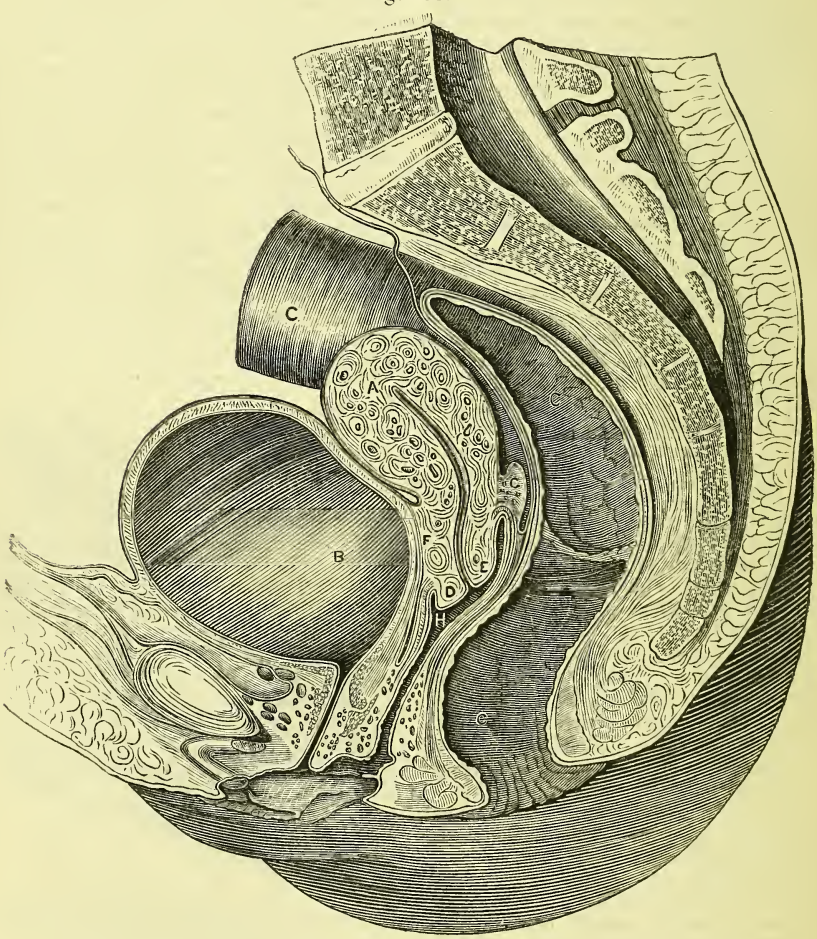
* This figure is from a valuable Memoir on the Pathology and Treatment of Leucorrhœa, in vol. xxxv. of the Medico-Chirurgical Transactions, 1852; where will be found also a description, with illustrations, of several of the natural and abnormal forms and conditions of the cervix.

into folds whose offices will be presently more specially considered. At the lateral lines of junction of the two cervical walls, where a crease or furrow is formed by the sudden bending of the parietes, an imperfect raphé is sometimes found, uniting a portion of the plicæ; but more commonly the laminæ of one surface either pass over and become united at their extremities with those of the opposite side, or else upon reaching the lateral angles they split up into smaller divisions, which are again gathered into the single folds upon the opposite side, their junction being then effected by the interposition of a cribriform surface.

The central raphé and lateral plicæ proceeding from it, under whatever form they may appear, constitute together a series of primary folds, from which others of a secondary order are produced. These emerge from either side of the lateral plicæ, and, crossing the furrows between them, subdivide again and again until the whole surface presents that cribriform aspect which can be just discerned by the naked eye, but cannot be accurately examined without the aid of the microscope. Here also are found in countless numbers these mucous crypts, which apparently furnish the peculiar secretions of this portion of the uterus (*fig.* 432.).

Structure and arrangement of the tissues composing the uterus.— The uterus is usually described as consisting of three coats, viz., an outer or serous, a middle or muscular, and an inner or lining membrane, commonly termed the mucous coat. But these coats cannot, like the three coats of an intestine, for example, be separately displayed, because each passes so imperceptibly into the others, that although to the naked eye an apparent distinction may

Fig. 433.



Section of female pelvis and its contained viscera. (*After Kohlrausch,*—reduced.*)

A, uterus; B, bladder; C C, rectum; D, anterior, and E, posterior lip of cervix uteri; F, connective tissue uniting the anterior wall of the cervix to the bladder; G, lax tissue between the posterior wall of the cervix and the peritoneum; H, vagina.

* Zur Anatomie und Physiologie der Beckenorgane, von Dr. O. Kohlrausch, Leipzig, 1854.

be observed, this distinction in a great measure vanishes under the application of the microscope.

Peritoneal coat. — The outer serous coat, which constitutes the thinnest of the three component tissues of the uterus, is formed of the centre of the principal fold of the broad ligament, which is closely applied to the uterine body and fundus, and to a portion of its neck.

It is of great importance to the comprehension of certain points in the pathology of the uterus, to be hereafter considered, that the relations of this peritoneal covering to the proper structures of the organ, as well as to adjacent parts, should be accurately determined. The most important of these relations are shown in *fig.* 433., representing a vertical section of the pelvis and its contents. In this view the reflexions of peritoneum over the centre of the uterus are shown. The membrane, after lining the abdominal walls, and covering the fundus, and a portion of the posterior surface of the bladder, is suddenly arrested in its descent at a point very nearly opposite to, but sometimes a little below the internal os uteri, and therefore about the seat of junction of the body with the neck of the uterus. Here the membrane forms a sharp fold or angle, and becomes immediately applied to the anterior face of the uterine body, while the cervix, which lies in great part, if not entirely, below this level is left uninvested. The peritoneum, then, after ascending over the anterior uterine wall, covers the fundus and sides of the organ, and descending upon the posterior surface, it remains closely adherent to the tissues beneath, until it reaches the level of the anterior point of reflexion. At this point the peritoneum becomes much more loosely connected with the uterus by the interposition of a quantity of lax connective tissue which intervenes between it and the posterior cervical wall (*fig.* 433, G). The membrane, however, still descends, covering first the posterior wall of the supra-vaginal portion of the cervix, and then a part of the fornix, or upper end of the vagina. The extent of peritoneal covering which the vagina receives, varies in different subjects from half an inch to nearly an inch. The membrane then, as before, turns upwards, but at a more obtuse angle, to invest the rectum, so that a pouch is formed, termed the recto-vaginal or retro-uterine pouch, which is sometimes of considerable size.

The adhesion of the peritoneum to the uterus is closest along the median line, and over the whole of the fundus, at which points its separation by dissection from the tissues beneath cannot be effected without the aid of prolonged maceration; but towards either side of the organ the connection is less intimate, so that here the membrane may be made to glide to a limited extent over the sub-lying structures. At the two upper uterine angles the peritoneum is continued on to the uterine appendages; viz., the Fallopian tubes, round ligaments and ligaments of the ovaries. After sending off extensions to invest these parts, the portions of membrane which cover the anterior and posterior faces of the uterus respectively come nearly into apposition along the lateral borders of the organ (*fig.* 427.), where they are conjoined by a quantity of lax fibrous tissue, which serves to bind them loosely together, and at the same time to give support and protection to the numerous blood vessels entering the uterus on either side along the whole of this border.

A similar portion of lax fibrous tissue serves to connect the anterior wall of the uterine cervix, where it is uncovered by peritoneum with the posterior surface of the bladder, with which it lies in contact.

The sectional views of the uterus in three directions already given serve to explain the whole of the relations of the outer or peritoneal coat of the uterus to the muscular or proper coat.

Fig. 426. shows the mode of attachment of this membrane to the anterior and posterior surface and fundus along the median line, and also the parts which are left uncovered by peritoneum. Commencing from the os uteri the vaginal portion of the cervix forming the anterior lip (*a*) receives an investment of mucous membrane as far as its point of attachment to the anterior wall of the vagina (*v a*). Beyond this the whole of the remaining portion of the anterior wall of the cervix, measuring above one inch in length (*b b*), is left uncovered either by mucous or serous membrane. At the termination of this space the peritoneum, reflected off from the bladder, reaches the uterus, and after investing the organ, is continued down to and beyond the fornix of the vagina (*f*). But at this point the mass of loose connective tissue before referred to separates the peritoneum from the posterior cervical wall to a great extent (*c*), while finally a much larger portion of the cervix is contained within the vagina, posteriorly than anteriorly, and is consequently covered by mucous membrane(*p*), because the vaginal walls are attached at a much higher point here than anteriorly.

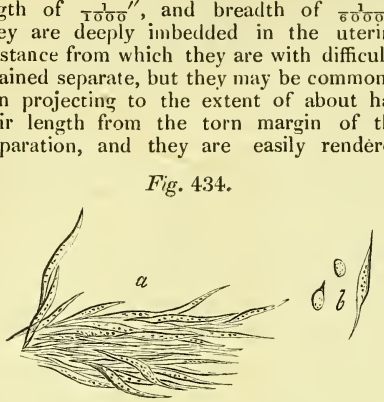
Fig. 431. serves to exhibit the relations of the peritoneum to the fundus, and the absence of that membrane from the lateral borders of the uterus, while *figs.* 427.—430. exhibit the relative proportions of the covered and uncovered parts as seen in a series of horizontal sections of different portions of the organ.

The middle or smooth-muscular coat, upon which depends the remarkable firmness and solidity of the uterus, constitutes the principal bulk of the organ. This coat upon section appears of a pale pink colour, mottled with irregular white lines, and permeated by vessels which are particularly numerous near its lateral borders. The following are the component tissues of the middle uterine coat, viz.:—

1st. *Smooth-muscular fibres.* — These are found in every portion of this coat, and consist of fusiform fibres of the kind termed by Kölliker contractile fibre-cells, in which a single elongated oval nucleus may be occa-

sionally brought into view with difficulty. They all contain minute dark granules easily distinguished, and they sometimes exhibit upon their surface slight longitudinal folds or markings. These fibres have an average length of $\frac{1}{1000}''$, and breadth of $\frac{1}{6000}''$. They are deeply imbedded in the uterine substance from which they are with difficulty obtained separate, but they may be commonly seen projecting to the extent of about half their length from the torn margin of the preparation, and they are easily rendered

Fig. 434.



Smooth-muscular fibre of uterus.

a, fibres united by amorphous matrix; *b*, separate fibre and elementary corpuscles. (*Ad Nat.*)

visible in its substance by the aid of dilute acetic acid. These fibres do not apparently possess any distinct cell membrane. In very thin sections the ends of the fibres which have been transversely divided are seen as if solid, and the cut fibres do not collapse, nor have I ever been able to detect any appearance of a flowing out of fluid contents, which would be the case if the individual fibres consisted of a cell wall containing fluid (*fig.* 434. *a*).

2. *Round and oval nuclei, or elementary corpuscles.*— These measure $\frac{1}{6000}''$ in diameter. They are found in many parts intermixed with the fusiform fibres, but they are most abundant towards the inner layers of the muscular coat. They are apparently the elementary or embryonic condition of the fusiform fibre-cells just described. For although the two extreme forms of round corpuscles and fusiform fibres are the conditions under which these constituents of the muscular coat are most numerously seen, there may yet be traced a sufficient number of apparently intermediate stages to justify the conclusion that the one is but the embryo form of the other; the round corpuscles becoming at first oval, and then being lengthened out into the fusiform state (*fig.* 434. *b*).

3. *Amorphous or homogeneous connective tissue.*— A considerable portion of connective tissue exists in certain parts of the uterus in the unformed state, constituting a transparent matrix in which the fibre-cells and nuclei are embedded, and by which they are so intimately united together, as to render their isolation, even with the aid of nitric acid, a work of great difficulty. The fibre-cells and nuclei which form the innermost laminæ of the muscular coat, as well as the laminæ themselves, appear to have scarcely any other connecting medium but this, especially in young subjects, while in the middle and outermost laminæ a large portion of fibrillated tissue is added, and the amorphous substance uniting the individual fibres into bundles is proportionally less in quantity.

4. *Fibrillated connective tissue* (white fibrous tissue). This, as just stated, is found chiefly among the middle and outer muscular laminæ, serving here the purpose of a connecting medium between the several layers, and supporting the blood-vessels ramifying between them. The presence of this form of fibrous tissue is most readily exhibited by taking a thin perpendicular section from the outer muscular layer, and slightly drawing the laminæ asunder, after submitting the preparation to the action of acetic acid. The layers and bundles of muscular fibre, as shown in *fig.* 437., are then seen to be surrounded by, and imbedded in, a quantity of white fibrous tissue which conceals the fibre-cells, and renders the distinguishing of them difficult.

The fibres of this tissue have clear and sharp edges, appear to be of indefinite length, are independent of each other, and are clearly not mere foldings in an amorphous substance. Among them, however, and especially at the points where the laminæ are separated, are seen numerous thin flat transparent bundles, marked by deep longitudinal wavy lines, to which the above explanation of the cause of the appearance of wavy lines in this tissue which many physiologists have adopted might be more safely applied. Occasionally these wavy bundles exhibit an appearance of sharp curling lines, such as would indicate the intermixture of a small quantity of elastic tissue.

5. *Elastic fibrous tissue.*—The elastic form of fibrous tissue is also present in the uterus, as just stated, though not in great quantity. Besides the occasional presence of strongly curled fibres there may be seen in many places developed single fibres matted together, of the finer kind, commonly known as nucleus fibres; and also more abundantly the peculiar fusiform formative cells from which these arise. I have frequently had the opportunity of tracing these peculiar dark-bordered cells in process of transformation into the finer elastic fibres, and so far of confirming those views which ascribe to this form of fibre a cell origin.

These several tissues together with the uterine vessels and nerves, the former being in great quantity, make up the middle coat of the organ. And it is to the arrangement of these in laminæ and bundles which are separated from each other, and perforated as it were in all directions by numerous vascular channels, that the mottled appearance of the unimpregnated uterus, as seen in sections, is due.

The foregoing constituents of the middle uterine coat exist in different proportions in the body and neck of the organ respectively. In the body, notwithstanding the considerable amount of fibrous tissue by which the several component elements are connected together, the muscular fibre, either in its elementary or more developed condition, constitutes the

largest portion, while in the cervix the fibrous element predominates, and the muscular fibre is proportionally less abundant.

Course of the muscular fibres. — Regarding the precise plan of arrangement of the constituent tissues of the middle uterine coat, and especially of its muscular element, in the unimpregnated state, numerous microscopic examinations have satisfied me that it is not possible to do more than to indicate these in a very general manner. Mme. Boivin attempted to describe the special course of the muscular fibres in the unimpregnated organ; but she appears to have abandoned the attempt after giving an account of what is seen upon the surface of the organ when the peritoneum has been stripped off after prolonged maceration. More recently the course of these fibres has been described by Kölliker, Gerlach, and others, in the deeper seated, as well as in the superficial layers.

In investigating this part of the subject it appears to me that a sufficient distinction has not been made between the course of the individual fibres, and the arrangement of the laminæ or bundles into which they are collected, for these are by no means necessarily the same.

According to my observations the contractile fibre-cells are not distributed in equal proportions through all parts of the muscular coat, nor are they found everywhere in the same condition. It has been already stated, that no strict line of demarcation is discernible by the microscope between the three several coats, of which the uterus is said to consist. And this is particularly the case in respect of the muscular fibres which permeate all of them. In the so-called mucous membrane the muscular fibre-cells are loosely arranged in an amorphous tissue, in which they lie embedded, intermixed with the elementary nuclear corpuscles, constituting their embryonic condition. Here the fibre-cells form bundles, situated between the ramified canals or utricular glands of the uterus, and take a direction more or less oblique or perpendicular with regard to the inner uterine surface. But at the level of the base of the uterine follicles, where the proper muscular coat is considered to begin, and the mucous membrane to terminate, the contractile fibre-cells assume a different direction and arrangement. Here at once they begin to exhibit a certain order of stratification, the strata being very closely superimposed, and arranged for the most part in such a manner as to lie parallel with the walls of the uterine cavity, which is therefore surrounded by them.

These strata exhibit certain differences of composition and arrangement sufficient, for the sake of description at least, to justify an artificial division of them into three orders.

The innermost of these may be termed the dense muscular strata. They commence immediately external to the mucous membrane, and extend outwardly through about half or two thirds of the thickness of the muscular coat.

When preparations that have been preserved in weak spirit, or those that have been finely injected, are examined by the naked eye, or with a hand lens, a peculiar mottled appearance is presented by sections of this part,

Fig. 435.

Thin section of a portion of the uterine walls, commencing from the peritoneum and extending inwards, showing the irregular course of the strata of uterine fibre, and the divided vessels between them. (*Ad Nat.*)

caused by the intermixture of numerous minute white lines ramifying within a darker substance, and dividing it into a multitude of small lozenge-shaped spaces. The whiter lines mark the course of the finer uterine vessels, together with the bundles of white fibrous tissue which accompany them. The browner lozenge-shaped spaces consist of the fusiform contractile fibre-cells, united together by amorphous tissue into short bundles, which by their superposition constitute the laminæ just mentioned. When horizontal sections are made of this portion of the muscular coat, such as are represented in *fig.* 428., these bundles or strata are seen to be arranged in a concentric manner, forming interrupted circles surrounding the uterine cavity. But this appearance must not be regarded as indicative of any corresponding direction of the muscular fibre-cells, within these bundles or laminæ, for all appearance of a concentric plan, as regards the fibres, at once vanishes under the use of the microscope.

Fig. 436., representing a fine section taken from the inner muscular laminæ, serves to exhibit the mode in which the contractile fibre-cells are arranged in this portion of the uterine walls. The individual fibres and embryonic corpuscles are imbedded in an amorphous substance (the unformed connective tissue already described), by which they are aggregated together, so as to form bundles and laminæ. In these strata the fibre-cells appear to remain distinct, and to be separated from each other by a distance not greater usually than their own diameters.

This is best shown in fine sections, previously prepared by acetic acid ; but it should be observed, that as this agent causes the intermediate tissue to swell, the normal distances between the cells may, to a certain extent, be thus artificially increased. The

Fig. 436.

Portion of uterine tissue from the internal muscular layers. (*Ad Nat.* × 150.)

relation of the fibre-cells to the uniting material is most clearly exhibited in those parts of the preparation where the knife has divided the fibres transversely to their long axes. Here the relation of these two structures to each other may be exemplified by that of the harder and softer ingredients in certain portions of those geological formations termed conglomerate.

At the points where the knife has cut the fibres obliquely, a corresponding change is observable in the outlines of the divided fibre-cells, which present in these bundles the figure of caudate cells, while in other places, where the course of the fibres has run parallel with the surface of the section, the fusiform outline of the entire length of the fibre is distinguishable.

All these varieties of direction are noticeable in *fig.* 436., in a portion of uterine tissue not more than $\frac{1}{50}''$ in diameter. The fibres which are here seen forming bundles and layers, run in some instances parallel with the surfaces of the laminæ, and in other places spread out fan-shaped, or incline towards each other, like the component fibrillæ of the penniform muscles. The bundles and layers of fibres are close-set and compact, and a comparatively small amount of developed or fibrillated connective tissue is found between or among these elements of the innermost strata of the muscular coat. The fibre-cells also are here apparently softer and more fleshy, and appear to be of newer formation than those forming the layers which lie nearer to the peritoneum.

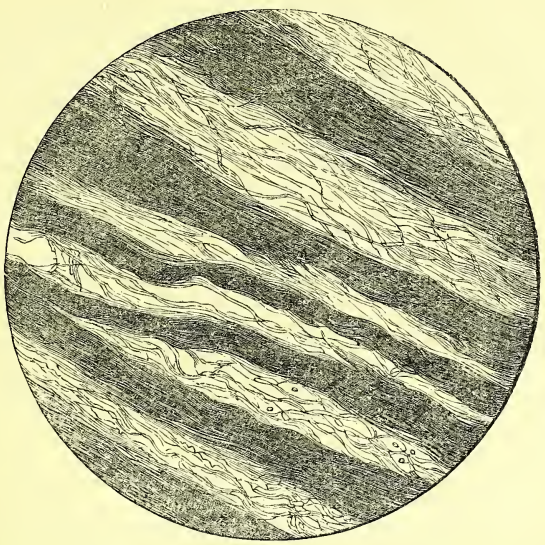
External to and surrounding these may be distinguished a second order of strata, among which the primary and secondary ramifications of the principal uterine arteries and veins are freely distributed ; so that sections taken from this region do not present the same compact appearance as those from the inner layers, but are seen to be everywhere permeated by vascular channels, which are particularly conspicuous in the multiparous uterus. These numerous vessels, ramifying among the muscular fibres, make the course of the latter very irregular. When the section has been made parallel with the broad ligament, the tortuous arteries, entering the uterine texture between the folds of the latter, may be often traced to a considerable depth among the laminæ ; while sections made in an opposite direction more frequently exhibit the gaping orifices of these vessels, and of the divided veins surrounded by laminæ of muscular fibres, and of a more lax and fibrillated form of connective tissue, than is found among the inner strata. This intermixture of the larger uterine vessels with the muscular strata constitutes here a very characteristic feature, and hence these middle strata may be distinguished as the vascular laminæ of the muscular coat.

External to these again lie a series of thin sheet-like laminæ (*fig.* 437.), forming a tegumental stratum which does not entirely surround the organ, nor cover it in all its parts. It consists of 6—12 thin close-lying layers of fibres, whose course is parallel with the uterine surface ; the most external laminæ

being inseparable from the peritoneum by which they are covered. These flat, thin, layers are continuous with and extended upon and into the broad and round ligaments, the Fallopian tubes, and the ligaments of the ovary, from which they spread out fan-shaped over the fundus and upper portion of the anterior and posterior uterine walls; meeting at length in a central perpendicular raphé, in which a few longitudinal bundles may be generally seen.

These tegumental laminæ are composed almost entirely of fusiform fibres, with very few embryonic corpuscles. They are united

Fig. 437.



Portion of uterine tissue from the external muscular layers close to the peritoneum. (*Ad Nat.* × 150.)

together by a large proportion of strongly fibrillated connective tissue, which is, however, sufficiently lax to permit a certain amount of artificial separation of the laminæ.

Within these laminæ the fibre-cells are arranged in a manner somewhat different from that which characterises the internal strata. The amount of amorphous connecting matrix is here so small that the fibre-cells lie apparently in close apposition, their extremities interdigitating with each other, so as to form an imbricated pattern (*fig.* 434.). These fibres do not so frequently change their course as the fibres of the innermost strata, but form a more continuous series; so that sections of this part of the muscular coat are easily obtained, exhibiting the appearance of longitudinal strata, or bundles of fibre, such as are represented in *fig.* 437. The course of the individual fibres within them is, however, traced with difficulty, on account of the large quantity of fibrillated connective tissue by which these layers are surrounded and conjoined.

Immediately beneath the peritoneum all the constituents of the muscular coat are condensed into a tissue which cannot be easily unravelled. Through this, however, numerous fibres may be seen to run in a direction more or less perpendicular to the surface, apparently for the purpose of connecting the peritoneum with the coat beneath.

The mucous or deciduous coat; Lining membrane of the cavity of the uterus.—This forms a moderately thick and soft layer which lines the entire cavity of the uterus, and is continuous with the lining membrane of the Fallopian tubes, and of the cervical canal. On account of the large supply of capillary vessels which it receives, the mucous membrane is usually distinguished from the rest of the uterine parietes by its brighter red colour. It presents also to the unaided eye, when horizontal sections are examined, an appearance of being thrown into minute folds running perpendicular to the uterine cavity (*fig.* 438.). These apparent foldings, however, are shown by a strong lens to consist of a series of ramified canals, which constitute the most remarkable peculiarity of this membrane. The proportionate thickness of the mucous membrane relatively to the rest of the uterine walls, though variable in respect of age and other circumstances, is usually about $\frac{1}{8}$th of their diameter. Its greatest thickness is found about the middle of the cavity, while towards the internal os uteri, and still more in the region of the fundus, the thickness is slightly diminished.

To the unaided eye, the mucous membrane lining the body of the uterus, when viewed from the uterine cavity, is apparently smooth, or is seen to be perforated by minute apertures, but it rarely presents the appearance of deep folds or plicæ such as are always found in the cavity of the cervix. Occasionally the surface is roughened and floculent from the exfoliation of its epithelial cover-

ing. The appearance of minute perforations is then lost, and a tomentose or apparently villous condition of the surface occasioned by the loosening out and partial detachment of the capillaries which freely ramify within this membrane is observed.

The lining membrane of the uterus differs from mucous membranes in general in having no sub-mucous tissue, so that it cannot, like that of the intestines, be made to glide upon the sublying tissues, nor be dissected off from them so as to be displayed in a distinct layer. When very thin sections from spirit preparations are examined by transmitted light with a common lens, or with a low power of the microscope, the mucous is distinguishable from the muscular coat chiefly by its greater opacity and peculiar greyish colour, as well as by the numerous tortuous canals which permeate its substance, running chiefly in a direction perpendicular to the inner surface of the membrane, and strongly resembling in their general contour the cerebral convolutions.

Under the application of dilute acetic acid this comparative opacity and grey hue immediately disappear, and the tortuous canals alone serve to mark the boundary between the two coats. When an amplifying power sufficient to discriminate the component tissues is employed, the distinction between the two coats becomes still less apparent, because their constituent elements are then seen to pass from the one to the other by almost imperceptible gradations, the difference between them being then shown to be morphological rather than structural, at least, at the points of their confluence.

The mucous membrane lining the uterine cavity is composed of the following elements, besides the utricular glands, capillary vessels, and epithelium, viz., — free elementary corpuscles or nuclei, contractile fibre-cells, and amorphous connective tissue.

1. *Free elementary corpuscles or nuclei.* — These are in all respects precisely similar to the elementary corpuscles already described as constituting apparently the embryonic state of the contractile fibre-cells in the muscular coat. They form in conjunction with the amorphous matter the principal portion of the uterine lining membrane towards its inner surface. Here they are arranged in nearly close apposition, being imbedded in an amorphous blastema, yet not so closely as to cause any mutual disturbance of their round or oval forms.

2. *Fusiform fibres or contractile fibre-cells.* — In the account which has been already given of the muscular coat, the contractile fibres are described as existing in all the coats of the uterus. In the mucous membrane they are very abundant, especially towards the outer surface, or that part in which the muscular and mucous coats become conjoined, and where the transition from the one to the other is almost imperceptible, and is chiefly observable on account of the difference in the arrangement of the constituent tissues of each. The fusiform fibres of the mucous membrane are gathered into loose bundles, united by amorphous tissue and intermixed with the elementary corpuscles from which they are developed. These bundles, the form of which is sometimes like the head of an arrow, are usually found between the utricular glands, pointing in a direction perpendicular to the uterine cavity.

The individual fibres have here a softer, paler, and more fleshy aspect than in any other portion of the uterine coats; they are apparently the youngest and most newly formed of the muscular fibres composing the uterus.

3. *Amorphous connective tissue* constitutes the chief bond of union between the several elements of the uterine mucous coat, and enters largely into the composition of the utricular glands. It presents no special character requiring a more particular description than has been already given of it in the account of the muscular coat.

Utricular glands or follicles. — These structures, which were first more particularly described by E. H. Weber and Professor Sharpey, constitute the most remarkable characteristic of the uterine mucous membrane.

By Reichert*, who has also investigated the subject, they were found present in every mammal which he had examined. The uterine glands or follicles consist of involutions or depressions of the mucous membrane, which are exceedingly numerous, and lie tolerably close together. They generally present the form of canals taking their course from the muscular walls of the uterus, through the substance of the parenchyma of the mucous membrane towards its free surface, where they terminate each in a separate orifice.

In Ruminantia and Pachydermata they are large, and take a serpentine direction, so that they may be easily mistaken for vessels. By Burckhardt †, indeed, who has described them in the cow, they were termed vasa spiralia. Their spiral course is more obvious in the rodentia and carnivora. In the rabbit they are short and wide. The orifices by which the utricular glands terminate upon the surface of the mucous membrane are in some animals large enough to be distinguished by the naked eye, as, for example, in ruminants, and occasionally in man; but more frequently these require the aid of a lens for their detection.

In the dog, two sorts of glands are described by Professor Sharpey ‡, simple and compound. The simple glands, which are the more numerous, are merely very short unbranched tubes closed at one end; the compound glands have a long duct dividing

* The composition of the mucous membrane of the uterus has been carefully investigated by Robin and Reichert; vide Robin, "Mémoire pour servir à l'Histoire Anat. et Path. de la Memb. Muqueuse Utérine; Archiv. Gen. de Méd. iv. série, tom. xvii.; Reichert, Ueber die Bildung der hinfälligen Häute; Müller's Archiv für Anat. Phys. 1848.

† Observ. anat. de Uteri Vaccini Fabrica.

‡ Müller's Physiology, by Baly, 1837, p. 1574.

into convoluted branches; both open on the inner surface of the membrane by small round orifices, lined with epithelium, and set closely together.

In man the form of the uterine follicles is by no means so definite as in the dog; nor is it possible by any mode of dissection with which I am acquainted to isolate and display them separately.* They form in fact a system of tortuous canals ramifying in the substance of the mucous membrane, in which they seem as it were to be excavated. They are so closely set as apparently to possess no distinct boundary wall, but each canal is separated from those contiguous to it by a variable thickness of parenchyma, consisting chiefly of the elementary corpuscles and amorphous tissue just described, together with a certain admixture of fibre-cells, usually found near the basal ends of the glands. No section that I have ever made has succeeded in exhibiting even a single gland divided longitudinally in such a way as to lay open the canal in its entire length, but every section made perpendicular to the surface presents the same appearance of numerous close-set meandering canals laid open for short distances, and giving to the surfaces of the section an outline

Fig. 438.

Section of the entire thickness of the uterine mucous membrane (decidua) in the unimpregnated state, with a small portion of the muscular coat attached.

The pale tortuous lines exhibit the course of the canals, termed uterine glands, the darker intermediate substance forms their walls. The finer lines are the capillaries of the mucous membrane injected. (*Ad Nat.*)

exactly resembling the cerebral convolutions. On account of this peculiarity it is difficult to determine whether these so-called glands consist of single isolated canals, or of a series communicating with each other. For the same reason it is also difficult to ascertain the precise mode of their termination towards the muscular coat, whether in a blind extremity in every case, as Weber represents them, or whether by any indirect communication with the uterine vessels, which many considerations both physiological and pathological seem to point out as at least possible. The difficulties attending this part of the enquiry have been ably illustrated by Dr. Sharpey, and my own investigations fully confirm his statements upon this point. Nevertheless I have in many instances succeeded in distinctly observing the blind termination of these canals towards the muscular coat.*

When sections of the mucous membrane are made parallel with, instead of perpendicular to, the surface, these canals are seen divided across. The appearance then presented is that of numerous round or oval apertures, which are more distinct in proportion as the section is made nearer to the uterine cavity.

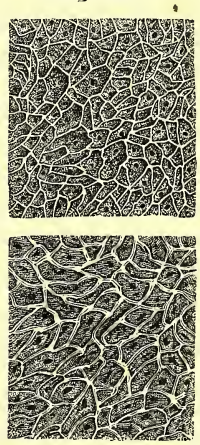
The uterine glands are lined by a fine dentate epithelium, the cells of which are only slightly coherent at their margins.

The orifices by which they terminate upon the surface of the uterine cavity vary in diameter from $\frac{1}{200}''$ to $\frac{1}{500}''$.

In addition to the glands or canals already described, there may be often observed intermixed with them short mucous crypts, or even closed follicles. These appear to have been little noticed in the uterine cavity, but they are very distinctly seen when accidentally distended by accumulation of fluid. They then constitute a variety of those growths, which in more advanced stages have been designated by Dr. Oldham channel polypi.

The arrangement of the *capillary vessels* of the uterine mucous membrane is peculiar and

Fig. 439.



Net-work of capillaries on the surface of the mucous membrane of the uterus.

a, from the body; *b*, from the canal leading to the Fallopian tube. In the centre of each of the meshes is the orifice of a uterine gland. (*Ad Nat.*)

characteristic. The capillaries, which are of large size, usually descend between the canals of the uterine glands, giving to them a few

* It appears to me that the well-known representations of the human uterine glands by E. H. Weber (Zusätze zur Lehre vom Baue und den Verricht der Geschlechtsorgane, Taf. viii. f. 4, 5.) are too definite, and should be regarded rather as diagrams than actual representations of what is seen in any mere section. Though it should be observed that these figures are taken from the pregnant uterus where the glands have enlarged and become more distinct.

* Upon this subject see further, p. 666.

small branches in their course. Having reached the surface of the mucous membrane they spread out into a meshwork of round oval and hexagonal spaces, in the centre of each of which may be usually observed the orifice of a uterine gland. This is most easily seen in the neighbourhood of the Fallopian tubes, where the capillary network and glandular orifices are usually arranged with greater regularity than in other portions of the uterine cavity.

In many places, however, the small vessels furnishing the capillaries of the mucous membrane may be seen in injected preparations, lying close beneath the surface with which they run parallel, and if the veins have been filled, one or two principal ones may be noticed on each half of the median line, running in the longitudinal direction, and communicating by short branches with the capillaries just mentioned, from which the blood is thus conveyed away through the muscular walls to the larger veins.

The network of capillaries thus formed lies very superficially with regard to the uterine surface. The layer of epithelium covering them, and the nuclear corpuscles and amorphous tissue supporting them, appear to have so little cohesion, and to form so slight a protection, that the vessels are often seen to be nearly bare, while in some instances the individual capillaries may be observed hanging out loose into the uterine cavity, and giving to its surface a villous appearance. This constitutes one of those conditions which have led many anatomists to assert, and more to deny, that the mucous membrane of the cavity of the uterus is furnished with true villi.

Structure and arrangement of the tissues composing the cervix. — The cervix is composed of nearly the same elements as those which form the body of the uterus, but they are differently proportioned and arranged in the two organs.

The cervix cannot be said to consist, like the body, of three coats. It receives a covering of peritoneum only upon its posterior surface, while the anterior wall, as well as the lateral borders, remain uninvested. With the exception, therefore, of this partial covering, the cervix consists of a muscular and a mucous coat only (*fig.* 426—431.).

Muscular coat of the cervix. — On account of the large admixture of fibrous tissue with the muscular element here existing, this might with almost as much propriety be called the fibrous coat of the cervix. The muscular element of the cervix consists of the same fusiform fibre-cells as in the body; but the elementary corpuscles are here scantily seen. The fibrous element consists of long detached fibrils or of bundles of fibres of white fibrous tissue intermixed with much unformed material of the same kind, but stronger and tougher than that which unites the constituents of the muscular and mucous coats of the uterine body.

These several tissues are arranged in a manner not materially different from the plan already described as observable in the body of the uterus. But the thin external strata which form the tegumental layers of the body are wanting in the cervix. There may, however, be distinguished an outer and more vascular, and an inner and more dense series of laminæ. The laminæ of the outer series are intermingled with numerous divisions of the cervical branches of the uterine vessels which traverse them obliquely in a direction from above downwards and from without inwards. From the abundance of these vessels the external laminæ present a more spongy appearance, and when the part has been injected a much deeper colour than the inner layers, which are paler, more dense and closely set, and exhibit at the same time fewer sections of vessels, and these only of the finer kind. The large amount of white fibrous tissue, and the density and compactness of the laminæ here formed around the cervical canal, give to clean sections of this part an appearance of circles concentrically arranged. But a low magnifying power is sufficient to resolve these into the lozenge-shaped spaces already described, consisting of bundles of contractile fibre cells bordered by fibrous tissue, and intermingled with bundles of the latter and blood-vessels of various sizes. Within these laminæ and bundles the fibres take their course with as many variations in direction and plan of arrangement as are noticeable in the muscular fibres of the rest of the uterus. (See *fig.* 436.)

The larger proportion of the fibrous element in the neck as compared with the body of the uterus, which the microscope serves to display, and which to a certain extent is observable to the naked eye, may be more satisfactorily shown by the operation of dilute acetic acid; this agent causing thin sections of the part rapidly to swell out and assume a gelatinous appearance.

Mucous coat of the cervix. — This is composed of epithelium, basement membrane, and the usual fibrous and vascular tissues, together with certain papillæ and follicles. It is of a more dense and uniform texture upon the outer or vaginal portion of the cervix than within the canal, where it is more delicate, but being here thrown into numerous folds and rugæ, an appearance is given of greater thickness than the membrane really possesses. The average thickness of the mucous membrane upon the lips of the cervix is $\frac{1}{2}$ — $\frac{1}{3}'''$; that of the membrane within the cervical canal, regardless of the folds, is somewhat less. The general plan of arrangement, and some of the more prominent forms which this membrane assumes within the cervical canal having been already considered, it only remains here to describe the minuter structures of which it consists.

The epithelium of the outer or vaginal portion of the cervix is tessellated or squamous. It gives a smooth and even covering to the two lips of which this part of the cervix consists. Outwardly, this scaly epithelium is continuous with that of the vagina, but towards the os uteri it terminates at the margin

of either lip. Within the cervical canal the epithelium changes its form. It has been described here as constantly cylindrical or dentate; but upon all the finer structures here found, such as the filiform papillæ, this so-called epithelial covering consists, as Reichert has well described, and Kilian accurately represented it, of elementary cells, whose cell membranes are closely united together, having a polyhedral outline, and without undergoing such an amount of flattening as to lose their spherical form. They contain a slightly flattened nucleus with several nucleoli, surrounded by a clear somewhat thick fluid intermixed with molecular bodies, and sometimes oil globules.

Some difference of opinion exists as to the part of the cervical canal in which the epithelium first becomes ciliated. Drs. Tyler Smith, and Hassall, who have examined numerous uteri at an early period after death, with a view to anticipate post-mortem changes, state that the ciliation of the epithelium commences in the rugose portion of the canal, and extends up to the fundus, while the epithelium just within the os, though also cylindrical, is not ciliated.* It should be observed, however, that there is no particular portion of the cervical canal in which the membrane constantly becomes rugose, but that the rugosities often extend quite down to the margin of the os. According to Henle†, the cervix is provided with ciliated epithelium from the middle upwards, and with pavement epithelium from that point downwards.

One peculiarity or variety in the arrangement of the epithelium upon the vaginal portion of the cervix requires special notice here on account of the singular degree of importance which has of late years been attached to it, and still more from the remarkable pathological speculations to which it has given rise.

It occasionally happens that the tessellated epithelium of this part, instead of extending as far as the os, abruptly ceases at a distance of one or two lines from the inner margin of either or both lips, leaving a single or double crescentic patch where the ordinary pavement epithelium is replaced by a crop of close-set filiform papillæ, projecting very slightly, if at all, above the general surface, and presenting to the touch that velvety feel, and to the eye, on account of their great vascularity, that florid aspect, which has often led to the supposition that this mere morphological variety of structure is the result of a pathological change, and that it constitutes a form of ulcer peculiar to the os uteri.

Beneath the epithelium is a *basement membrane*, which, upon the outer portion of the cervix, extends in a smooth lamina over the papillæ that everywhere crowd this part, but within the cervical canal it dips into the furrows and follicles, or covers its numerous rugosities and projections.

An unequal layer of *fibrous tissue*, traversed by vessels, and supporting and containing the numerous papillæ and mucous crypts of various forms and sizes which characterise the cervical mucous membrane, completes this structure. Tough and coriaceous upon the outer portion, and thinner and more delicate within the canal of the cervix, it forms the chief substance of the mucous membrane, and lies immediately upon the muscular coat, the fibres of which become intermingled with it.

The papillæ, or villi, as they are sometimes termed, of the cervix, exhibit considerable varieties of size and figure, being conical, verrucose, or tuberculated, dentate, clavate, and filiform. The clavate papillæ are usually found fringing the surface and margins of the thinner plicæ. The dentate usually form a border to those which are a little more fleshy, and are commonly seen at the margins of the lateral and upper mucous folds. The verrucose papillæ are seen in various situations, but are most constantly observed in the sharp lateral furrows which constitute the lines of demarcation between the two cervical walls. The filiform papillæ are the finest of all. They are more slender and pointed than the clavate. They occur under two forms, and in two situations.

One of these forms is invariably present on the outer or vaginal part of the cervix. The whole of this portion, from the margins of the os outwardly, is covered by numerous short close-set thread-like papillæ, invisible to the naked eye, but with the help of a sufficient amplifying power easily distinguished by their white colour, through the somewhat dense layer of pavement epithelium and basement membrane that closely covers and binds them down. Similar papillæ clothe the inner surface of the vagina, and form, with those just described, a continuous layer.

The filiform papillæ constituting the second variety are larger and longer than these, so that they may be discerned by the naked eye. They occur usually at the margins of the os, and may be traced to a variable distance within the canal. But their presence here is uncertain, while that of the former variety is constant in the situations indicated. These larger filiform papillæ may be sometimes seen to form the terminations of the longitudinal cervical plicæ in those cases where parallel folds run down to the very margins of the os uteri. Here the folds, each ending in a little tuft or tassel, form by their junction a close-set crop of villi, which may merely border one or both lips with a narrow fringe, or form a velvetty patch extending outwardly upon the lips of the cervix, and being here uncovered by the ordinary dense epithelial layer of this region, which, as just stated, sometimes, terminates at this spot with an abrupt margin, they may present the appearance already described as simulating an ulcer.

Regarding the *minute structure and composi-*

* Memoir on the Pathology and Treatment of Leucorrhœa, based upon the microscopical anatomy of the os and cervix uteri.—Med. Chir. Trans., vol. xxxv. 1852.

† Allegem. Anatom., p. 246.

tion of the papillæ, all but the finer kinds may be viewed as consisting of the same elements as the mucous membrane itself, for they appear to be produced by mere notchings or indentations, extending more or less deeply into that membrane; they are, in fact, little more than repetitions of the plicæ and sulci upon a smaller scale, with a slight difference of form. They serve to extend the secreting surface, and possibly to expose a larger aggregate superficies of vascular and nervous tissues.

One or more long and slender blood-vessels may usually be traced from the muscular coat running into each papilla. These are sufficiently conspicuous in thin sections without the aid of injections. By the aid of the latter they may be seen to terminate in vascular loops upon the ends of the papillæ, just as similar vessels may be observed to form wavy coils upon the crests of the plicæ by which the cervix is lined.

The filiform papillæ, both larger and smaller, are more finely-constructed than the rest. They often end in a slightly bulbous extremity. Those upon the outer portion of the cervix are usually single, their length being from two to six times that of their breadth. The free uncovered filiform papillæ of the cervical canal and margins of the os are relatively much longer. These latter are commonly branched, and in conformation occasionally resemble the early villi of the chorion. Each villus, whether single or ramified, contains usually a single capillary loop, which returns upon itself, and at the base passes on to another villus. Covering the capillary loop is a delicate basement membrane, uniting together the clear granule-holding nucleated cells, which constitute the epithelial covering as well as the substance of the villi, and of which a description has been already given.

No nerves have been traced into the papillæ, though Kilian* is of opinion that they are specially tactile or sensitive structures, and from various circumstances to be hereafter considered, it will appear probable that they are connected with the special nervous attributes of the cervix. I am disposed, however, to regard the sensibilities of the cervix, such as they are, as resident chiefly in the filiform papillæ.

The *mucous crypts or follicles* of the cervix are, for the most part, simple depressions in the mucous membrane, although in certain situations they penetrate more deeply, and approach in form the ramified and tortuous canals of the uterine body. Scarcely any portion of the cervical canal is free from these follicles, which serve to increase the extent of mucous surface, and apparently to furnish the special secretions of this part. They not only fill all the interspaces between the primary and secondary folds, but they are dotted over the ridges and prominences of the cervical lining membrane in countless numbers, extending from the internal to near the external os uteri. They commonly cease at a short distance from the margins of the latter, where a smooth space is often observable in one or both cervical walls. But they may be sometimes perceived at the very border of the lower orifice, and when in such a case one or both lips are slightly everted, as for example in certain hypertrophies of the cervical lining membrane, this follicular portion becomes protruded, while its florid colour, limited by an abrupt margin of the unaltered and paler squamous epithelium here suddenly commencing, an appearance is produced which may also easily be confounded with an ulcer.

The mucous crypts seldom extend beyond the border of the os, except in the cases just quoted, when, in fact, the relative situation only of the parts is changed. A few, however, may be sometimes seen scattered at tolerably regular intervals over the vaginal portion of the cervix. They sometimes also occur here, as well as within the cervix, and even in the uterine cavity, in the form of closed vesicles containing an opaline fluid, and perhaps may be regarded as in some instances pathological new formations.

The cervical mucous crypts are lined by epithelium and basement membrane. They contain a small quantity of mucus, together with granule cells. Those upon and near the margins of the os uteri may be sometimes observed to contain short papillæ within their margin.

Blood Vessels of the Uterus.

The Arteries are derived from two sources, viz. from the internal iliac and the ovarian or spermatics.

The vessels supplied from the former source are termed the uterine arteries. These are two in number, one for each side. They arise from the anterior division of the internal iliacs, and proceeding downwards and inwards pass between the folds of the broad ligament to the neck of the uterus. Here they take an upward course along the lateral border of the organ, describing several flexuosities, and giving off, in succession, branches to the upper part of the vagina, the neck, body, and fundus of the uterus; the latter inosculating with the branches derived from the spermatics. Free inosculations also take place in the substance and upon the surface of the uterus between the branches of the two sides, so that the entire uterus may be injected from either set of vessels.

The branches derived from the spermatic or ovarian arteries also enter between the folds of the broad ligament, and inosculate with the superior divisions of the uterine vessels near the fundus of the organ.

When, after a successful injection, thin slices are cut from the substance of the uterus and dried, and afterwards placed in Canada balsam, the whole appears to be a mass of vessels; the arrangement of which, however, may be easily

* See a valuable paper by Franz M. Kilian, entitled, Die Structur des Uterus bei Thieren, in Henle and Pfeufer's Zeitschrift, IX. Bd.

observed by a hand lens or a low power of the microscope. Many of the arteries down to $\frac{1}{10}'''$ or $\frac{1}{15}'''$ in diameter are still seen to take a remarkable corkscrew course, with numerous very close spirals, especially in the outer half of the sections. Beyond these the vessels take a straighter course, and at length, in their finer divisions, run in parallel lines, sending off minute twigs at right angles, which cross the ultimate fibres of the tissue, in the manner peculiar to muscular structure.

When the finer vessels of the *body* of the uterus have reached the mucous membrane, they dip down between the walls of the canals, termed uterine glands, and spread out in a network of capillaries; the meshes of which surround the orifices of those canals in the manner delineated in *fig.* 439. *a* and *b.*; and from these the blood is again collected by the small superficial veins, the course of which is described at p. 637.

The arteries which supply the *cervix* penetrate that part in a direction downwards and inwards, pursuing the same corkscrew course until they have nearly reached the mucous surface, where they break up into finer vessels and capillaries, which ramify over the rugæ in lines more parallel than those of the uterine body. Both the arteries and capillaries of the cervix are far less numerous than those of the body of the uterus; and, indeed, the cervix generally in respect of its composition exhibits a lower degree of organisation than that of the principal portion of the organ, although it appears to receive the largest supply of nerves.

The *veins* of the uterus take a course corresponding with that of the arteries, and are distinguished by the same names. They are considerably longer and more numerous than the latter. They form along the sides of the uterus and within the folds of the broad ligament a very considerable plexus (the uterine plexus), which, together with the venous channels or sinuses ramifying in the uterine substance, are more conveniently examined in the gravid organ, where they undergo great enlargement. See *figs.* 444. 449. and 453., and the descriptions of these.

Lymphatics. — These vessels are far more easily examined in the gravid than in the unimpregnated uterus. They are very numerous, and are divided by Cruveilhier into two orders; the superficial, which lie immediately beneath the peritoneum; and the deep-seated, which ramify in several places in the substance of the uterine walls. The lymphatics of the cervix terminate in the pelvic and sacral glands. Those of the body of the uterus, after traversing the broad ligaments and uniting with the lymphatics proceeding from the Fallopian tubes, ovaries, and round ligaments, empty themselves in the glands situated in front of the aorta and vena cava.

Nerves. — The nerves which supply the uterus are derived partly from the spinal, but principally from the sympathetic system. According to the dissections of Dr. Snow Beck *, the nerves which compose the hypogastric plexus, consisting of gelatinous and tubular fibres derived from the lower part of the superior aortic plexus *, on approaching the neck of the uterus begin to separate, and on a level with the os uteri are joined by branches which accompany the superior hæmorrhoidal artery. The anterior portion of the hypogastric plexus, after receiving branches which accompany the iliac arteries, passes inwards by the broad ligament, and supplies the lower half of the uterus. These nerves, which are continuations of the hypogastric plexus, as they approach the body of the uterus separate, and each pursues a different distribution. They lose the plexiform character and form a number of distinct fine cords.

These nerves, like all the nerves supplied to the uterus, are chiefly composed of gelatinous fibres, although some tubular fibres accompany them; but they are few in number, and appear to be far from forming the essential element of the uterine nerves.

The middle portion of the uterus is supplied by a distinct branch from the inferior aortic plexus; which, without communicating with the hypogastric branches, passes to the upper part of the uterine body and then divides, to supply the part between the previously described branches and the Fallopian tube, sending also a branch to the ovary.

The fundus is supplied sometimes by a

* Phil. Trans., 1846, part ii. p. 219.

* According to Dr. Snow Beck, the white tubular fibres which enter, pass through, and emerge from the *semilunar ganglia*, are all derived from cerebro-spinal nerves through the medium of the *splanchnic nerve*, while none of the tubular fibres actually arise from the ganglia (as Bidder and Volkmann suppose). The same was found to obtain in every instance of sympathetic ganglia examined; the tubular fibres could always be traced to the white connecting cord between the spinal and sympathetic nerves, and thence to the branch of the spinal nerve from which it is derived. The gelatinous fibres, on the other hand, all take their origin in the corpuscles of the ganglia. In the white cords connecting the spinal and sympathetic nerves, commonly regarded as roots of the sympathetic, the tubular fibres composing these, on being traced back to the spinal cord, were found to be derived from the motor and sensitive roots in apparently equal proportions. The elements of the lower part of the *superior aortic plexus* resemble those which form the semilunar ganglia, viz. tubular fibres derived from the lumbar nerves, and gelatinous fibres from the sympathetic ganglia.

The *inferior aortic plexus* is a continuation of the branches from the plexus last described. These divide to form the two lateral hypogastric plexuses, and here a crossing of fibres of the opposite side takes place.

The *lateral hypogastric plexus* is composed of gelatinous and tubular fibres derived from the superior aortic plexus. The distribution of nerves to the uterus from this, their main source, is described in the text.

The *sacral nerves*, although they supply the vagina, clitoris, labia, sphincter and levator ani, bladder, and rectum, send no direct branches to the uterus; nor is there, according to this author, any anatomical evidence to support the supposition which some have entertained, that filaments derived from these nerves might by a circuitous route reach the uterus after their union with the *pelvic plexus*. Phil. Trans., 1846, part ii.

branch which proceeds from the renal plexus in company with the spermatic artery, and is distributed also to the ovary.

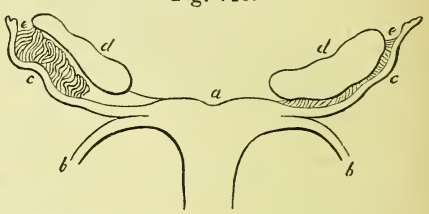
Another set, distinct from these nerves, comes also from the same continuation of the hypogastric plexus, but forms a plexiform arrangement around the vessels; and among these are found here and there minute ganglia. These nerves are very minute.*

The Development of the Uterus, and the Metamorphoses which it undergoes at Different Periods of Life.

a. The origin of the uterus, and its condition during fœtal life. — In the human embryo, according to the observations of Müller, during the transformation of the Wolffian bodies, the efferent tube of the generative apparatus undergoes the following modifications. In the male, all that portion of the efferent tube which passes along the outer border of the corpus Wolffianum is thrown into strongly marked convolutions, and this part contributes to the formation of the epididymis, while below this point the convolutions cease; and here a band or ligament, the gubernaculum testis of Hunter, which had been developed at a still earlier period, passes off to the inguinal canal. In the female, the following transformation occurs. The tube here remains free from convolutions, but a ligament, resembling that of the male, which is afterwards converted into the ligamentum uteri teres, passes off from the same point, to be extended to the inguinal ring. The part of the tube which lies below this point becomes the cornu uteri, and it is by the coalescence of the two cornua at their lower extremities that the body of the uterus is formed in man; while in those animals in which no middle portion or body exists, the cornua remain ununited. As the development of the uterus proceeds, the two cornua become gradually shorter, until at length they are lost, or, as it were, absorbed into the body or fundus of the uterus, which is thus at the same time developed.

The accompanying figure, representing the

Fig. 440.

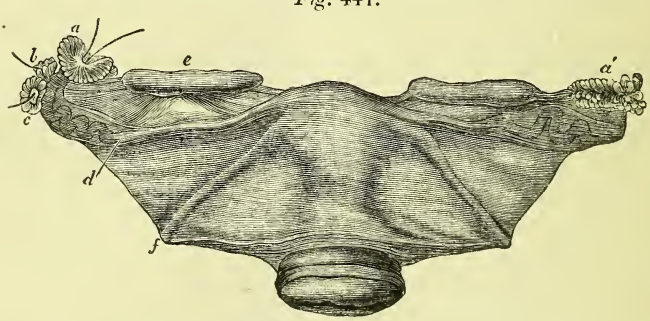


The entire internal generative organs, from a fœtus of three months. (*After J. Müller* × 8.)
a, uterus; *b*, round ligaments; *c*, Fallopian tubes; *d*, ovaries; *e*, remains of Wolffian bodies.

condition of the fœtal uterus at about the end of the third month of gestation, serves to illustrate these particulars. The ovaries possess the elongated form characteristic of the early condition of these organs. Parallel with them run the Fallopian tubes, and between these are the remains of the Wolffian bodies. At the point where the round ligaments are given off, the cornua uteri begin, and by their junction, which is here not yet complete, so that a slight indentation is left, the uterus is formed.

From this period of embryonic life, the uterus keeps pace in its growth with the other

Fig. 441.



Uterus and appendages of human fœtus at term. (*After Richard.*)

á, pavilion of the left side; *a*, the same of the right side (below it, in this specimen, is the remarkable variety of two separate accessory pavilions *b* and *c*); *d*, Fallopian tube, exhibiting numerous sinuosities in its outer half; *f*, round ligament; *e*, ovary.

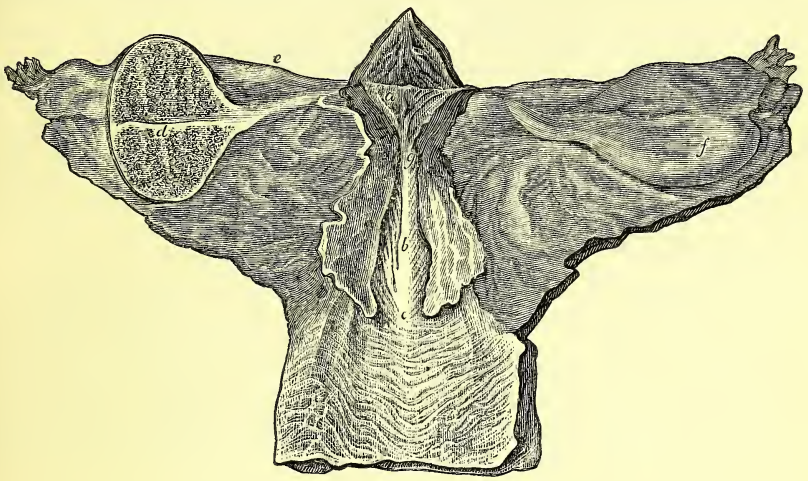
viscera; and at the time of birth it forms an organ of considerable size, lying high up in the pelvis, and occupying a conspicuous place midway between the bladder and rectum. The form, however, of the generative apparatus, at this stage of life, is very different from that which characterises it at a later period. The vagina, cervix, and body of the uterus constitute one nearly straight stem or canal, from which diverge, at right angles, the Fallopian tubes and ovaries with their ligaments, much in the form of the letter T. Of the two divisions of the uterus, viz. the body and cervix,

* Upon the subject of the origin and distribution of the uterine nerves, consult also Fr. Tiedemann; Tabulæ nervorum uteri, Heidelberg, 1822; and the works of Dr. Robert Lee, quoted at page 651., where the condition of these nerves in the gravid uterus, and the question of their enlargement during pregnancy, is considered. And for the minute anatomy of the sympathetic filaments and ganglia, see the Art. "Sympathetic Nerve."

the latter is the more considerable, for the body has not yet acquired breadth; while the cervix, forming a tube of nearly equal calibre with the body, possesses almost twice its length. This greater length of the cervix, as compared with the body of the uterus, is one of the most striking characteristics of fœtal life (*fig.* 441.), one also which continues to be observed for many years after birth.

b. The uterus from the time of birth to puberty. — From the time of birth until the approach of puberty, the internal generative organs undergo but little change. Gradually, but slowly, increasing in size, they still retain the principal characteristics of the fœtal period. The uterus consists still chiefly of cervix, the body being that part which is last developed. Thus in a child of three years (*fig.* 442.), in whom the entire length of the uterus is 15‴, the cervix measures 11‴, and

Fig. 442.



Uterus and appendages of an infant.

a, cavity of the body laid open; *b*, of the cervix; *c*, anterior lip of the cervix; *d*, left ovary opened; *e*, Fallopian tube; *f*, right ovary; *g*, internal os uteri, marking the division between the body and cervix. (*Ad Nat.*)

the body only 4‴. These dimensions do not materially differ from those of the uterus in the first year of life, nor do they much exceed those of the same organ at birth.

But as puberty approaches, the relative proportions of the cervix and body of the uterus are found to have changed, and the latter now preponderates over the former. For while the body now equals the cervix in length, the breadth of the former much exceeds that of the latter. The walls of the upper chamber now become thicker from the more rapid development of the uterine muscular fibre, which is their chief constituent. This not only increases the external dimensions of the organ, but, at the same time, causes the parietes to become incurved, and so to encroach upon the cavity contained by them, which, up to this period, preserves the form of a nearly equilateral triangle (*fig.* 442.), but now gradually acquires the shape already described as characteristic of the cavity of the adult uterus (*fig.* 431.).

The folds or plicæ also (*fig.* 442.), which, in infantile life, are distinguishable upon the anterior and posterior walls of the cavity in the uterine body, resembling somewhat those in the cervical canal, gradually disappear; their former situation being now indicated by only a slight groove or raphé in the median line, and one or two gentle elevations diverging towards either Fallopian tube. These traces in the cavity of the body of its original construction out of two symmetrical halves, become generally lost after the uterus has been once impregnated, and indeed cannot always be distinctly seen in the nulliparous organ. One peculiarity in the form of the infantine uterus may be mentioned here, although it will be subsequently more particularly noticed. This consists in a curvature or inclination forwards of the upper part of the uterine body (*fig.* 467.). It is constantly more or less seen in infancy and childhood, and is usually partly retained in the virgin adult, but becomes lost after one or two pregnancies. In an excessive degree, it constitutes the condition hereafter described as antiflexion of the uterus.

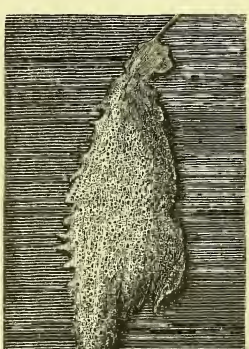
From the time of birth to puberty, the component elements of the uterus remain nearly unchanged. They consist of granules and cells in various stages of development, from the round granular corpuscle to the elongated and ultimately fusiform fibre-cell; the two latter being often drawn out, at their extremities, into long filiform threads. These are all imbedded in a semitransparent formless matrix, and differ in no respect from the corresponding tissues in the adult, except that they are ge-

nerally softer and less tenacious in proportion as they are younger.

c. The uterus during menstrual life. — The average duration of menstrual life is thirty years. It occupies usually the interval between the ages of fifteen and forty-five. The uterus in healthy women, throughout this entire epoch, is maintained in a state of perfect aptitude for the reproductive office, being, so to speak, under the control of the ovaries, with which it manifests so direct a sympathy, that every periodic change in the condition of the latter is, so far as the present state of our knowledge justifies the assertion, represented by a corresponding preparatory change in the former. But the menstrual phenomena being reserved for subsequent notice, it is only necessary to remark here that the uterus undergoes usually a slight alteration in size about the time of each catamenial flow, when its tissues are opened up, and become more spongy from the larger afflux of blood to them.

The lining membrane appears to suffer a variable amount of disintegration. In the uterus of women who have died during menstruation, the interior may present a slightly roughened appearance in certain places, or this may extend over the greater portion of the cavity. In women who menstruate painfully, it not infrequently happens that the entire uterine lining, to a greater or less depth, is exfoliated and discharged; the process of expulsion being accompanied by much suffering and a greater escape of blood than occurs in ordinary menstruation. These dysmenorrhœal membranes (*fig.* 443.) present all the characteristics of a true decidual structure, having upon their inner side, or that which had corresponded with the uterine cavity, the fine cribriform surface occasioned by the orifices of numerous utricular glands, and upon the reverse side the usual rough flocculent appearance characteristic of the outer surface of membranes ordinarily discharged, along with the ovum, in abortion.

Fig. 443.



*Portion of the lining membrane of the uterus cast off during painful menstruation. (Ad Nat.)**

* For this illustration I am indebted to Dr. Oldham.

In other respects, the uterus, throughout menstrual life, exhibits little or no alteration in form or bulk, but continues to present those characteristics of constant aptitude for its greatest and most important office, which have been explained in the description already given of the adult organ; and these characteristics, if no pregnancy intervenes, it preserves until the period arrives at which menstruation, together with the capacity for procreation, finally ceases.

d. The uterus during gestation. The fully developed uterus. — The gravid uterus is only another term for the fully developed uterus; for, although the latter designation is commonly applied to the unimpregnated organ, when it has reached its ordinary size in the adult, the uterus does not attain the greatest amount of development of which it is normally susceptible until the term of gestation is complete.

The case of the uterus is perhaps in certain respects *sui generis;* for it is the case of an organ which, having reached a certain period of growth, remains in a nearly passive condition, so far as mere growth is concerned, until a further amount of development is evoked by a new stimulus. There are, indeed, two notable periods in the history of the development of the uterus, at which the influence of such an additional stimulus is perceptible.

For, first, as already shown, the uterus, like the mamma, remains without any material change from birth to puberty. The establishment of the latter condition is characterised by a correspondingly rapid evolution of both these organs. But the pubertal age may not arrive; the individual may retain, in respect of reproductive capacity, the pre-pubertal condition; and the uterus, in these cases, does not proceed beyond its first stage of development.*

Again, the second stage, having been reached at puberty, may be continued through menstrual life, until, with the cessation of procreative power, the period of natural decline in the organ commences, and this is the condition which the part retains during the periods or intervals when it is not employed in the process of reproduction, as well as throughout life in those cases in which it is never so employed. This degree of growth of the uterus is evoked by the full development of the ovary and the commencing discharge of ova, and is coexistent with the establishment of menstruation and the other conditions of puberty.

But a third stage of development of the uterus is produced normally by the stimulus of impregnation, and partly by the growth of the ovum, and abnormally by the formation of

* Compare *fig.* 465., representing the pre-pubertal uterus in a woman aged nineteen, with *fig.* 442., of the uterus of a child at three years.

any substance within the uterus, such as a polypus, which may cause distension of its walls; or by the accumulation of fluid in its cavity, such as the menstrual fluid collected in cases of atresia or imperforation of the vagina.

The development of the uterus which is occasioned by the stimulus of pregnancy, takes place whether the impregnated ovum arrives within the uterine cavity or not; although this does not occur in equal degrees in the two cases. In the case of extra-uterine pregnancy, a very considerable thickening of the uterine substance usually takes place, together with a general enlargement of the entire organ, fully equal to that which is observed in the third month, and, in some cases, when gestation is not interrupted, even in the fourth month of ordinary pregnancy.

In cases where gestation follows an ordinary course, the development of the uterus is such, that the weight, at the end of the period, is found to be increased about twenty-four-fold, and its length about five-fold.

This development, as it affects the size, weight, form, and position of the entire organ, as well as the physical condition of its special parts, will now be considered.

There is no example in man, and few in the animal kingdom generally, of a development of any organ or structure comparable in rapidity with that which takes place in the uterus during gestation, although the periodical growth of the deer's horn, and the formation of the placenta, may be quoted as in some respects analogous cases.

Size. — The rate of increase of the uterus, during pregnancy, is subject to great variations. But, with due allowance for these, which are dependent chiefly upon the size of the fœtus and placenta, the quantity of liquor amnii, or the number of ova fertilised, an approximate estimate may be formed of the average alterations in size and bulk which the organ exhibits at different periods of normal gestation.

These may be expressed in calendar months as follows: —

RATE OF INCREASE IN SIZE OF THE GRAVID UTERUS ACCORDING TO MONTHS.

	Length.	Breadth.
End of 3 months	4½—5 inches	4 inches.
„ 4 „	5½—6 „	5 „
„ 5 „	6—7 „	5½ „
„ 6 „	8—9 „	6½ „
„ 7 „	10 „	7½ „
„ 8 „	11 „	8 „
„ 9 „	12 „	9 „

The antero-posterior has usually an average of one inch less than the lateral diameter.

Weight. — The weight of the gravid uterus, when fully developed, is most correctly ascertained in cases where death has taken place during, or soon after, labour at term. In twelve examples, estimated by Meckel, the minimum weight was 2lbs., and the weight, relatively to the unimpregnated organ, was as 24 to 1.*

Form. — The form of the uterus undergoes many changes in the course of gestation. During the first three months, although there is a considerable increase of size, the primitive figure is retained with only slight alterations. After the third month, the body rapidly enlarging, while the cervix remains nearly unaltered, the figure of the former approaches that of a sphere. For the perpendicular and transverse diameters of the body then become nearly equal, and the only deviation from the spherical form is occasioned, first, by the cervix, which increases the vertical diameter of the entire organ by one inch; and secondly, by the more tardy expansion of the body in the antero-posterior diameter, producing the form of a flattened sphere. After this, the perpendicular increasing more rapidly than the transverse diameter, and the upper segments widening faster than the lower ones, the uterus gradually acquires the ovoid figure which characterises it at the end of pregnancy.

Alterations, nearly corresponding with these, take place in the cavity of the uterine body. The walls of this flattened triangular chamber begin to separate from each other; and by their gradual expansion, the angles and superior and lateral lines, by which the cavity was at first bounded, are unfolded, so that the triangular is gradually exchanged for the pyriform shape, and this again for the figure of a flattened sphere — as in the fourth and fifth months of gestation; after which period the figure of the cavity corresponds very accurately with the general external form of the organ.

During these alterations, the fundus becomes strongly arched; while the sides undergo a slighter relative expansion, so that they exhibit only a gentle swelling; but the anterior and posterior walls become curved and prominent — sometimes the former, and sometimes the latter, according to Dr. W. Hunter, showing the greater amount of convexity.†

It has often been asked whether, during these changes, the walls of the uterus increase in thickness, or the contrary. In other words, whether the dilatation of the uterine cavity is to be regarded as a mere passive distension, with thinning of the walls; or whether the process of enlargement consists of an active excentric hypertrophy.

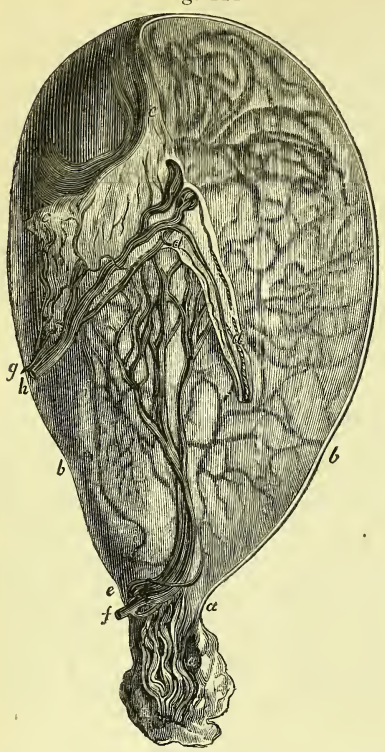
In order to determine this point, Meckel examined the average thickness of the uterine walls at different periods of gestation. From observations which he had made in sixteen uteri, at all periods of gestation, he concluded that the walls increase a little in thickness in the beginning, but that this increase is not very considerable, and that towards the end of pregnancy they become gradually much

* The estimates of Heschl, given at page 658., differ somewhat from these.

† W. Hunter. An anatomical description of the human gravid uterus, page 5.

thinner. He found the thickness of the uterine walls, three weeks after conception, 6‴;

Fig. 444.



Human gravid uterus at eight months. The vessels have been injected, and the peritoneum removed from the sides and fore-part of the uterus. (After Wm. Hunter.)

a, commencement of the cervix; *b b*, portion of the body corresponding with the brim of the pelvis; *c c*, Fallopian tube concealing the ovary; *d d*, round ligament; *e*, hypogastric artery, and *f*, vein; *g*, spermatic artery, and *h*, vein.

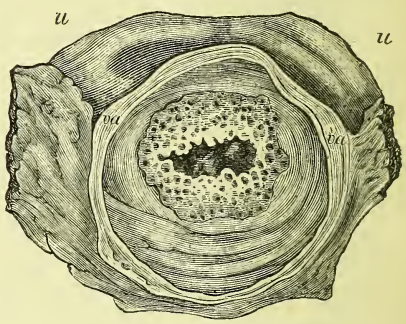
at the commencement of the third month, 5‴; at the commencement of the fourth month, 4‴. At the end of the fourth month, in two cases, 4‴; in a third, 3‴ at the upper, and 4‴ at the lower part; in a fourth, 5‴. At five months, in one case, 3‴; in another, 2‴ superiorly, and 4‴ inferiorly. At six and seven months, rather less than 3‴; at eight months, in one case, 2‴, and $2\frac{1}{2}$‴; and in another, 3‴ above, and more than 4‴ below. At nine months, they appear to be still rather thinner.

In several uteri, which I have examined at all stages of gestation, I have found the thickness of the uterine walls exceedingly variable in different instances, even at corresponding periods of pregnancy, and particularly variable also in different parts of the same uterus.* According to my measurements, the extremes of thickness range from 2‴ to 9‴.

* This circumstance is remarkably exemplified in prep. No. 3605, in the Museum of the Royal College of Surgeons, London.

During these changes, which take place in the uterine body in the course of pregnancy, similar, but much slighter, alterations occur in the cervix. For the latter, being only the excretory channel of the uterus, undergoes no further modification than is necessary to prepare it for transmitting the fœtus when fully developed. Accordingly, in the early months of gestation, while the body is rapidly enlarging, the cervix undergoes but little change. Its tissues, however, become slightly expanded, so that the whole part is thicker, softer, and more elastic than in the virgin state. The margins of the os externum are consequently rendered more cushiony, and the orifice itself is enlarged. The canal of the cervix is also widened, and the palmæ plicatæ become unfolded, and project in the form of frill-like expansions (*fig.* 446.); while an unusual activity, occurring in the crypts and follicles, by which these parts are covered, a tough gelatinous secretion is poured out, which

Fig. 445.



Os and cervix uteri in the eighth month of pregnancy.

The os is surrounded by a broad disc of enlarged cervical follicles filled with a gelatinous secretion. The os is represented as seen from the vagina. *v a*, vaginal walls divided; *u*, walls of uterus. Half the natural size. (*Ad Nat.*)

collecting here in the form of a plug, assists in shutting out the uterine cavity and its contents from contact of external air and other influences.

The increase in size of the os and cervix, which is gradually progressive through the whole of gestation, will be sufficiently expressed by comparing the dimensions of these parts in their two extreme states. The virgin cervix measures usually at the base 7—8‴ in its shorter, and 11—12‴ in its transverse diameter, and has an aperture of 3—4‴ wide. It projects into the vagina to the extent of 4‴ (*fig.* 425). At the end of pregnancy, the whole vaginal portion of the cervix would fill a circle of $1\frac{1}{2}$″ diameter; the orifice measures transversely 10—11‴; and that part which formerly projected into the fornix of the vagina, is now reduced nearly to the level of the vaginal walls.

During these changes, it is often observed, especially in a first pregnancy, that, as gestation advances, the projection of the cervix

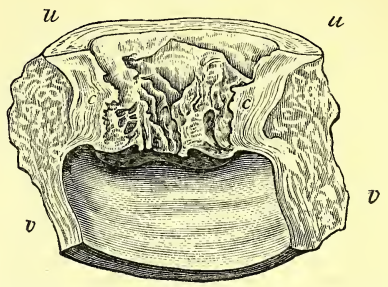
uteri into the upper part of the vagina becomes gradually less and less distinctly ascertainable by the finger. The latter change is commonly termed the "shortening of the cervix;" but the conditions upon which it depends, have not been very accurately examined, and they are certainly not at all clearly or adequately represented by the figures by which the description of this process is usually accompanied. As much importance is usually attached, in works on forensic and obstetric medicine, to the changes in question, it will be necessary here to examine a little more closely the process by which this apparent shortening of the cervix is produced.

It is commonly said that no material alteration, in the length of the cervix uteri, occurs before the fifth month of gestation; that, at the sixth or seventh month, the uterine neck has begun to shorten; at the eighth month, it is nearly, and at the end of the ninth month, it is quite, obliterated.

But while it is true that a lessening of the projection of the cervix into the vagina commonly takes place in pregnancy (*fig.* 446.), I can hardly coincide in the explanation which is usually offered of this circumstance, namely, that it is due to a gradual drawing up, as it were, of the cervix, by which its walls become added to those of the body of the uterus, for the purpose of increasing the capacity of the uterine cavity; and that in this way the uterine neck is gradually shortened, until it finally disappears.*

The accompanying *fig.* 446. exhibits the condition of the cervix in a woman aged thirty-seven, who, having previously borne children, died of phthisis in the eighth month of pregnancy. Here it will be perceived, that, without any actual diminution of the length of the cervix, which measured rather more than one inch, still there is no projection of it into the vagina; but that it forms a flat roof to that canal in the mode which is usually described and explained as indicating the entire absorption of the uterine neck. The true explanation of this, as it appears to me, is, that the apparent shortening of the neck is caused not, at first, by any diminution of its actual length, but by an increase of its breadth, or its extension in the lateral direction, whereby the projection of the lips into the vagina is reduced to the smallest possible amount. The rest of the process, upon which the shortening of the cervix depends, may be explained by the variable condition of the internal os uteri, or upper orifice of the cervix. If this remains unyielding until the time of labour,

Fig. 446.



Vertical section of the os and cervix uteri represented in the last figure.

v, walls of vagina; *c*, of cervix, and *u*, of uterine body. The cervical canal is nearly filled by the expanded palmæ plicatæ. Half the natural size. (*Ad Nat.*)

then the finger, on being placed within the cervix, traverses the whole length of the canal before it reaches any part of the child; and the general form and substance of the cervix being retained, the neck is said to be unobliterated. Such is usually the state of parts after repeated pregnancies. But if the internal or upper os yields readily, as it usually does in the more advanced stage of a first pregnancy, then the head of the child gradually settles down upon the lower orifice, pressing aside the soft and yielding wall of the cervix, which thus forms for it a shallow, cup-like, or funnel-shaped recess, that may be so far said to be added to the uterine cavity; and the finger, on passing within the os readily, touches the child, without having to traverse any length of cervix.

When, therefore, the term, shortening of the uterine neck, is employed, it should be understood to imply that change which takes place from the hypertrophy and lateral extension of the vaginal portion of the cervix, combined sometimes with a separation of the cervical walls from each other, occasioned by the descent of the head of the child; the degree of this descent being regulated by the amount of yielding of the internal os uteri. But it does not signify any alteration in the anatomical condition of the cervix and body of the uterus, which in every case retain their distinctive characteristics to the end of pregnancy: while the dilatation of the cervical canal is only an occasional occurrence, limited to the last stage of pregnancy, and having nothing to do with that apparent shortening which begins after the fifth month.

Position actual and relative. — The enlargement which the uterus undergoes during gestation, occasions of necessity very considerable alterations in its actual and relative position. On the occurrence of pregnancy, the organ, at first concealed within the pelvis, sinks, by its increased weight, lower than usual within that

* See description of the figures in Gooch: "An account of some of the most important diseases peculiar to woman," p. 212; and Beck's Elements of Medical Jurisprudence, 5th edit. p. 128.

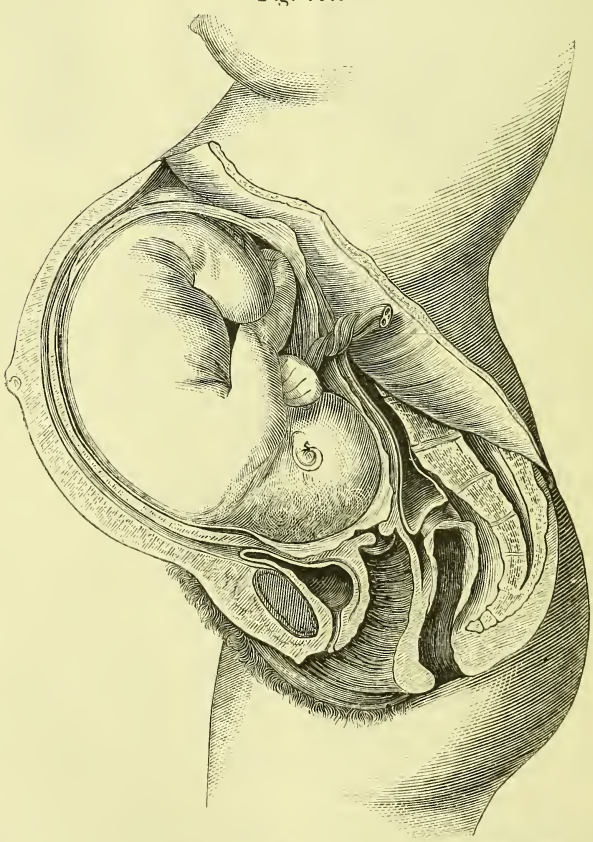
Regarding this explanation, which had been given by many preceding authors (see Mauriceau, tom. i. p. 97.; Smellie, vol. i. p. 183. *et seq.*), but which Gooch was, I believe, the first to illustrate by diagrams, it appears to me that much imagination has been exercised. The illustrations usually given are evidently diagrams supplied for the purpose of aiding the description of the process, as it has been supposed to occur, from examination of the part by the finger during life, but they give a very imperfect notion of the actual state of the cervix in pregnancy, as ascertained by dissection.

cavity; and, pressing upon the bladder and rectum, occasions sometimes an irritable condition of these parts. But usually at the end of the third month, the fundus may be felt emerging from the pelvic cavity; and in the course of the fourth month, it is always easily distinguishable in the lower part of the hypogastric region, having then risen to the height of about three fingers-breadth above the pelvic brim. In the fifth month, the hypogastric region is completely filled; the abdomen then acquiring a considerable rotundity in this situation. By the termination of the sixth month, the umbilical region also is filled, and the fundus uteri may be felt on a level with, or a little above, the navel. In the course of the remaining three months, the uterus rises gradually, until its fundus reaches the level of the ensiform cartilage. And this is very nearly the limit of its ascent, though it occasionally, and chiefly in first pregnancies, rises slightly above that point. In women who have a roomy pelvis, and in those cases where the natural form of the uterus is not altered by over-distension nor mal-position of the fœtus, there usually takes place, a few days or shortly before labour, a certain descent of the uterus, which has the effect of partially emptying the epigastric region, and relieving it from the pressure which it had sustained, especially during the last month.

The direction which the uterus takes in rising from the pelvis into the abdominal cavity, is determined by various circumstances; and it is interesting to observe in what way the addition of so large a body as the fully developed uterus to the already occupied abdomen, is provided for, without any of the viscera suffering injurious pressure, and without that impediment to the circulating and respiratory systems, which, in the absence of such a provision, must inevitably take place.

The oblique direction of the uterus, upwards and forwards, is determined, firstly, by the corresponding obliquity of the pelvis, the plane of whose brim forms with the horizon an angle of 60°. But as the fundus gradually, after three months, emerges from the pelvic cavity, the oblique direction of the uterus is maintained by the symphysis pubis in front, and the sacral promontory behind. Between these, the superior portion of the uterus continues to ascend, supported next by the abdominal walls anteriorly, and the spine posteriorly. The intestines, being bound down by the mesentery, cannot be displaced, and will

Fig. 447.



Position of the uterus at the end of pregnancy. (*After Maygrier.*)

therefore occupy a position midway between the spinal column and the posterior uterine wall. The pressure of the sacral promontory, and of the lumbar vertebræ, will still give to the uterus a forward tendency, which, on the other hand, will be prevented from becoming excessive by the elasticity of the front walls of the abdomen. If these have not been previously much distended, the fundus glides upwards, and ultimately fills the epigastric hollow; but if the abdominal walls have been much relaxed, as by frequent child-bearing, or if the pelvis is much deformed, the fundus uteri is usually turned directly forwards, or even downwards.

At the end of pregnancy, the whole of the fore part of the abdomen is occupied by the uterus; on either side lie the ascending and descending colon; the transverse arch, together with the omentum and stomach, fill the space between the fundus of the uterus and the diaphragm, while the rest of the abdominal viscera lie laterally and posteriorly to its hinder wall.

Thus it results, that in pregnancy, and especially in its last stages, no injurious pressure is exercised, either upon the great vessels, the aorta and vena cava, or upon the intestines, liver, or stomach, whilst the descent of the diaphragm, and, consequently, the act of respiration, is not materially impeded, and space is left for the bladder and rectum to perform their appropriate acts.

The situation and direction of the pregnant cervix, are necessarily affected by the increase of the principal organ, as well as by its contents. So long as the weight of the uterus causes it to descend lower into the pelvic cavity, as in the second and third months, the cervix is more readily reached, lying in the lower part of the hollow of the sacrum; but when the greater part of the uterus lies, as it does at a more advanced period, above the pelvic brim, the cervix is felt with greater difficulty, being more withdrawn from the entrance of the vagina. If the lower segment of the uterus is more than usually spread out, as in transverse presentations, or in the case of twins, or of excessive distension by liquor amnii, then the cervix and os are drawn up so high as sometimes to be quite beyond the reach of an ordinary finger; or, if the pelvis is very narrow, or the abdominal walls so lax as to cause the falling forward of the womb, the cervix will be equally beyond reach, and in these cases no part of the uterus can be said to be within the pelvic cavity. On the other hand, where the pelvis is unusually roomy, and the vagina and ligaments are lax, the cervix may lie immediately upon the perineum, or even project beyond the orifice of the vulva. In most cases the cervix lies lowest in the pelvis at the earlier and latter periods of pregnancy, and highest about and after the time of quickening. Its projection into the vagina is not always in the direction of the median line, but is more often inclined to the left side, as that of the fundus is towards the right. This obliquity in the position of the uterus may be caused by an unequal length of the ligaments, or more commonly by the projection of the lumbar vertebræ, which naturally gives to the body of the organ an inclination towards one or other side.

Alterations in the special coats and tissues.—*The Peritoneum* is that coat which suffers the least alteration during pregnancy, yet the changes which it exhibits are not inconsiderable. They consist chiefly in a simple multiplication of the component elements of the tissue, whereby it is enabled to keep pace with the enormous rate of growth of the uterus, so as still to invest all those portions which were covered by peritoneum in the unimpregnated state. During this process of growth, the membrane does not become attenuated, as would be the case if it suffered mere distension, but its thickness is rather increased, so that the addition of new matter must be in the aggregate very great.

Dr. W. Hunter imagined that this investment of the gravid uterus was accomplished by an unfolding of the layers of the broad ligament, for he asserts that, "in proportion as the circumference of the uterus grows larger, the broad ligaments grow narrower, their posterior lamella covering the posterior surface, and their anterior lamella covering the anterior surface of the uterus itself." He arrived at this conclusion from observing the altered relative situation of the appendages, and their appearance of clinging to the sides of the uterus in advanced stages of pregnancy. But the latter circumstance is due to the arching of the fundus, already described, which gives to the appendages a downward direction; while that the broad ligament does not disappear, as Dr. Hunter asserts, may be shown by measuring the alæ, or cutting them off, and comparing them with the same parts in the unimpregnated state, when little or no difference in respect of dimensions will be found between them in the two conditions.

Beneath the peritoneum of the gravid uterus is always found a large development of strong *fibrous tissue*, arranged in irregular cords and bundles. These sub-peritoneal fibres serve to strengthen the coats, and probably greatly contribute to prevent rupture of the organ, especially during labour.

The muscular or middle coat.—The tissues of which this coat is composed, together with their mode of arrangement in the unimpregnated uterus, have been already fully described. And it is to an increase of these, but especially of the vascular and muscular elements, that the enormous growth of the uterus during pregnancy is chiefly due. This growth consists partly in a greater development of the already existing structures, and partly in new formations.

The growth of the contractile fibre cells is here of especial interest. The elements of this tissue have been shown to consist, from infancy onwards, of fusiform fibre cells, intermixed with the round, oval, and elongated nuclei (*fig.* 134.), which constitute their embryonic

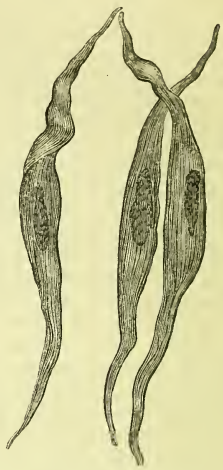
condition. These, up to the time of impregnation, form the special and sole elements of the muscular tissue; yet some physiologists even of the present day refuse to recognise in these a muscular character, although it is plain that the uterus so constructed has a contractile power. The occurrence of abortion, sometimes at the very beginning of pregnancy, the expulsion of polypi and dysmenorrhœal membranes, and the painful contractions termed uterine colic, prove that the unimpregnated uterus is so endowed. This non-recognition of a muscular character in the uterus before pregnancy has arisen from the minute size of the individual fibres, and from the difficulty of explaining why these should grow to a given point, and then cease to be developed. But F. M. Kilian has given a happy illustration of this point, derived from the observation of Kölliker, that the contractile fibre cells which are found in the coats of the smaller blood-vessels, preserve a relative proportionate size to those of the larger ones, wherein they are more fully developed. So also the contractile fibre cells of the uterus proceed to a certain point of development in the unimpregnated organ, and there stop. And in this respect it makes little or no difference whether the organ examined has been taken from an infant or an adult.

But when pregnancy takes place, the fibres proceed to a further stage of development. Their growth is now so considerable, that the contractile fibre cells, instead of a length of 0·002—0·003‴, and width of 0·002‴, in the fifth month, present a length of 0·06—0·12‴, and width of 0·0025—0·006‴, or even 0·01‴, and in the second half of the sixth month, a length of 0·1—0·25‴, a width of 0·004—0·005‴, and a thickness of 0·002—0·0028‴; consequently their length is increased from seven to eleven times, and their width from twice to five times.*

But in addition to this greater development of pre-existing fibre cells, a new formation of muscular fibre also takes place. This is observed, according to Kölliker, chiefly in the inner layers, although it may also occur in the external ones. The time of this new formation is chiefly the first half of pregnancy, the earlier forms of the fibre cells being no longer discernible after the twenty-sixth week. From this time onwards, the muscular coat contains only colossal fibre cells.

According to my observations, the individual fibre cells increase gradually in breadth throughout pregnancy, but their length is so variable, that the measurements just given can only be regarded as examples. The length, indeed, of the greater number of fibre cells after the third month cannot be determined with exactitude. A great many are thrown into numerous folds and contortions. Some exhibit transverse wrinkles, and the majority, when unbroken, end in long drawn out filaments, whose terminations become intermingled with the adjacent cells. Fine longitudinal markings are often distinguishable, and some fibres exhibit an elongated nucleus. The interior of the fibre is finely granular, and the margins show often a sinuous outline.

Fig. 448.

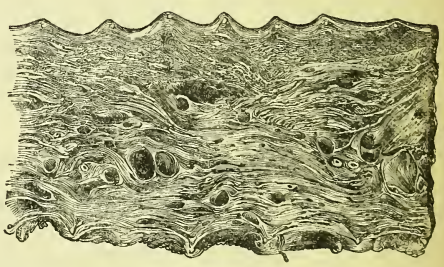


Fibre cells of gravid uterus fully developed. (*After Wagner.*)

The fibrous tissue uniting the several layers of muscles appears also to increase considerably, and towards the end of pregnancy to exhibit a distinct fibrillation.

These muscular and fibrous elements of the gravid uterus are arranged in numerous thin lamellæ, a good view of which may be obtained by cutting a thin slice perpendicularly out of the walls of the uterus at term.

Fig. 449.



Section of the entire walls of the uterus after delivery; showing the arrangement of the laminæ and the divided arteries and veins lying between them. (*Ad Nat.*)*

By gentle traction, the laminæ may be drawn partly asunder. They are then seen to be

* Kölliker, Manual of Human Histology, Syd. Soc. vol. ii. p. 259.; and Siebold and Kölliker's Zeitschrift, 1848, bd. I. p. 72.

* In order to obtain a correct representation of the course of the laminæ, I have here pinned out the preparation under spirit, and afterwards photographed it for engraving, of the natural size. By the stretching, the breadth of the preparation is doubled, and the laminæ are separated and rendered more distinct.

most densely and closely united towards the inner and outer surfaces, but to be more easily separable in the centre or vascular layer, where the laminæ are connected by a looser fibrous tissue, and are everywhere permeated by numerous large and small venous canals. These laminæ are superimposed the one upon the other, in layers parallel with the two surfaces of the uterine walls, but neither the laminæ themselves, nor the fibres composing them, can be said to take any definite course. Within the laminæ the fibres are arranged in flat bundles, which cross in all directions, as in the unimpregnated organ, but can seldom be traced in the same direction for any considerable distance. This is especially the case in the middle or vascular layer. In the superficial laminæ, the tendency of the fibres is to converge towards the angles to which the appendages are attached, while internally an apparent disposition to the formation of concentric circles around the orifices of the Fallopian tubes has been sometimes observed upon inverting the organ after labour. But nothing like a continuous arrangement of muscular fibres in the form of circular or longitudinal bands surrounding or investing the organ, can anywhere be demonstrated by the aid of the microscope.

The blood-vessels of the uterus undergo a marked increase in length, and especially in breadth, during pregnancy. The arteries pursue a remarkable spiral course whilst traversing the uterine walls. The veins form flattened channels between the muscular laminæ. The enlargement of the latter is accompanied partly by a growth of the muscular fibre cells already existing in their *tunica media* before pregnancy, and partly by a transformation of their inner and outer coats. Kölliker has observed, that in the fifth and sixth month, the fibres of the middle coat undergo an enlargement as considerable as those of the uterine walls, so that between these two scarcely any difference can be discerned. But besides these, both the inner coat, from the epithelium outwards, and the outer coat, acquire muscular fibres, which, except that they take a longitudinal direction, do not otherwise differ from those of the middle coat. This structure is found in the trunks of the uterine veins within the broad ligament, in the internal spermatics, and in all the veins of the uterine substances, which exceed 2‴ in diameter. In the smaller veins the muscular layer becomes less developed. Still, in those of ⅓‴ in diameter, a longitudinal layer of muscular fibre next the epithelium may be found. The only exceptions consist of those veins which, in the placental region, penetrate the inner layers of the uterus, to become continuous with the maternal veins of the placenta. These, notwithstanding their great width, instead of containing three, possess only one layer of muscular fibre, which, together with the epithelium, composes the entire coat of the vein.*

* Siebold and Kölliker's Zeitschrift, *loc. cit.* p. 84.

Do the nerves of the uterus enlarge or multiply during pregnancy?—This question, which once excited much controversy, has lost its chief physiological interest, since it has been determined that if any enlargement of the uterine nerves take place during pregnancy, this is nearly or entirely confined to the neurilemma, or fibrous nerve sheaths. Upon this point all observers are nearly or entirely agreed. Dr. Robert Lee states*, that whilst engaged in making dissections of the gravid uterus, he "discovered that the neurilemma was the constituent tissue of the ganglia and nerves which chiefly enlarged during pregnancy." Dr. Hirschfeld remarks, "this increase of volume does not occur in the nervous tubules, but in the neurilemma." M. Jobert de Lamballe having traced the nerves of the uterus in man and animals, both in the unimpregnated and gravid state, says, that he "never observed any modification of their physical condition. They appeared more voluminous in consequence of an infiltration of the cellular tissue which surrounds them, but they had not undergone any actual enlargement." Dr. Snow Beck removed the neurilemma, leaving only the bundles of nerve fibres or nerve tubules. On comparing the nerves of the gravid uterus with those of the unimpregnated organ, both dissections having been similarly conducted, he found that "the size of the nerves in both dissections is essentially the same; and when the nerves are carefully compared, no doubt is left that the nerves of the gravid uterus have undergone no change in size, nor any change in position, except that consequent upon the development of the organ."

But the neurilemma consists entirely of fibrous tissue, such as is common to most other parts of the body. It exhibits no structures specially nervous. Its offices, in relation to nerves and ganglia, are to support, protect, and bind together the nerve tubules and ganglionic nerve corpuscles.

Now the real point of interest to be determined is, whether during pregnancy the innervation of the uterus is increased in any degree proportionate to the augmented supply of blood to the organ. But the neurilemma has never been regarded as either a generator

* The Lancet, No. xvii. vol. ii. 1854, p. 349. Upon the subject of the nerves of the gravid uterus consult also, by the same author, "The Anatomy of the Nerves of the Uterus," 1841; "On the Nervous Ganglia of the Uterus," Philosophical Transactions, 1841, Part ii. p. 269.; 1842, Part ii. p. 173.; and 1846, Part ii. p. 211.; "Memoirs on the Ganglia and Nerves of the Uterus," 1849; and papers in the Lancet, vol. ii. 1854. Also the following:—Dr. Snow Beck, Philosophical Transactions, 1846, Part ii. p. 213.; and Papers in the Lancet, vol. ii. 1856; Jobert de Lamballe, "Recherches sur la disposition des Nerfs de l'Utérus," Comptes Rendus, 1841, p. 882.; F. M. Kilian, "Die Nerven des Uterus"; Zeitschrift, für Rat. Med., Henle und Pfeufer, Bd. X. 1851; M. Hirschfeld, "Note sur les Nerfs de l'Utérus;" Gazette Médicale, Oct. 1852, No. 44.; C. F. J. Boullard, M.D., "Quelques mots sur l'Utérus," 1853.

or conductor of nerve force, the former property belonging exclusively to the nerve centres, and the latter to the nerve tubes or nerve fibres. It is therefore necessary to ascertain if either nerve centres or nerve fibres become in any way multiplied or enlarged during the process of utero-gestation.

Regarding a new formation of nerve centres, there is at present no anatomical proof that any fresh ganglionic corpuscles are formed during pregnancy within the ganglia or plexuses from which nerves proceed to the uterine tissues.

Regarding the changes which take place in the nerve tubes or fibres during gestation, much interesting information is obtained from the researches of the late Dr. Franz M. Kilian, who devoted a considerable time to the investigation of this point. Dr. Kilian discovered, that in the unimpregnated uterus a successive diminution of the nerve fibre, whether in bundles or isolated, takes place as it approaches the point of distribution. If broad, the fibre, after a certain portion of its course, begins to lose its greater breadth, distinct double contour, and strongly marked granular contents, and then continuing as a pale fibre of intermediate size until it approaches nearer to the uterus, it ultimately assumes an embryonic character; that is, the extremely attenuated pale-margined fibre which traverses the tissues as a slender transparent band, has ceased to form a cylinder filled with nerve granules, and constitutes now only a pale slender stripe, or empty non-medullated sheath. Within this empty sheath there still occur, at distant intervals, little collections of granular fatty contents.

Now, in the early periods of pregnancy these embryonal forms are observed to become gradually more distinct between the muscular fibres, and at a later period many of the fine tubes become filled with medulla, which was wanting in the unimpregnated condition; the little collections of granular fatty contents just mentioned constituting the commencement of the nerve cylinders. For it is by the confluence of these isolated drops within the sheath that the medullated cylinder is formed, so that medullated fibres not only proceed as far as the uterus, but also become developed with continually increasing distinctness during pregnancy between the muscular fibres.

These observations correspond exactly with changes which Kilian observed to take place also in young animals, when the nerve fibres in the neighbourhood of the uterus are all in the embryonic condition, but become gradually medullated up to a certain point, in proportion as the development of the animal proceeds, so that the nerves may be said to grow forward in the direction of the uterus.

It should be understood, however, that in all these cases, the dimension of the nerve fibre never exceeds that of the branch whence it is derived, but that, on the contrary, a law of gradual diminution of the nerve is found to obtain in all cases, although the changes now described cause the rate of this to be different in the unimpregnated and gravid uterus respectively.

Kilian had no opportunity of examining the condition of the nerves in the human uterus at different periods of pregnancy, but he doubts not that the alterations are analogous to those which he found in animals.

The lining membrane of the uterus. Development of the decidua.— The last, and at the same time the most interesting, transformation of the uterine tissues remains to be described. It is that which takes place in the lining membrane, and which has for its object the formation of an immediate covering and protection to the ovum. By the aid of this membrane, the fertilised ovum, on arriving loose in the uterine cavity, is re-attached to the parent body, and is enabled to receive from it the supplies necessary for nutrition and growth.

But before the ovum enters the cavity of the uterus, the lining membrane of the latter swells and becomes softer and at the same time more vascular.* This augmentation in bulk of the uterine inner coat takes place in almost all cases when an ovum has been fertilised. That it does not depend upon the presence of the ovum in the uterus, is proved by the fact, that in cases of extra-uterine gestation, with rare exceptions, a development of decidua occurs within the uterus, forming there, in some cases, a more profuse growth even, relatively to the size of the uterus, than takes place in ordinary gestation.

The phenomena which ensue immediately

* In a paper on the Structure of the Placenta, by John Hunter, published in 1786 (Animal Economy), the decidua is described as composed of *coagulable lymph.* In another paper, 1794, on "the case of a young woman who poisoned herself in the first month of pregnancy," the pulpy substance lining the uterus, into which the blood-vessels of the uterus passed, and upon which they ramified, is stated to have consisted evidently of *blood coagulated.* The statements and descriptions in these two papers constitute the basis of the Hunterian hypothesis regarding the source of the decidua. But Dr. William Hunter had, even at that early period, a clearer perception of what the decidua really was, for in his posthumous work entitled "An Anatomical Description of the Human Gravid Uterus," edited by Dr. M. Baillie in 1794, the decidua is described in the following phrases:—"This membrane is an efflorescence of the internal coat of the uterus itself." . . . "It may be said to be the internal membrane of the uterus." . . . "It is really the internal lamella of the uterus." That the decidua constitutes simply a higher stage of development of the lining membrane of the unimpregnated uterus, in the same way that the muscular coat of the gravid organ is only a more advanced condition of the same coat before impregnation, is now proved beyond question. Upon this subject consult, in addition to the works quoted at p. 636., Sharpey, in "Müller's Physiology, by Baly," 1837, p. 1574.; Eschricht, "De Organis quæ Respirationi et Nutritioni Fœtus Mammalium inserviunt," 1837; F. M. Kilian, "Die Structur des Uterus bei Thieren," in Henle and Pfeufer's Zeitschrift, bd. ix.; Schrœder van der Kolk, "Waarnemingen over Het Maaksel van de Menschelijke Placenta;" and Coste, "Histoire Générale et Particulière du Développement des Corps Organisés."

upon the arrival of the ovum within the uterine cavity are, in the human subject, as yet unknown. Direct observation of the earliest stages are still wanting, and, unfortunately, the difference between these first steps in the mammalia (except Quadrumana) and man is so considerable, that only a limited aid can be derived from comparative observation. The ovum, when first found in the human uterus, is lodged in a small closed cavity, forming a continuous structure with the decidua which lines the rest of the uterine walls. In this little chamber, which may be formed at any part, but is most frequently seen near one or other of the tubal orifices, the little spherical ovum lies loose and unattached. In various examples which have been preserved and figured by different authors of the decidua at this stage, the size of this chamber varies from that of a pea to a hazel nut, and this size it acquires in the second week.

The walls of the cavity containing the ovum, and those forming the lining membrane of the uterus, are nearly alike in appearance and texture. They both consist of decidua, the former constituting the *decidua reflexa*, the latter the *decidua vera* of Dr. W. Hunter. For greater distinctness, those names are sometimes exchanged for *decidua chorii* or *ovuli*, and *decidua uteri*. The latter, according to a suggestion of Dr. M. Baillie, is also occasionally termed *parietal decidua*.

At this time all the uterine tissues have begun to expand and grow, and the uterine cavity, the walls of which were previously nearly in contact, to enlarge after the manner which in pathology constitutes eccentric hypertrophy. But, according to the foregoing description, this cavity now no longer forms one, but two compartments, the one partly inclosed within the other.

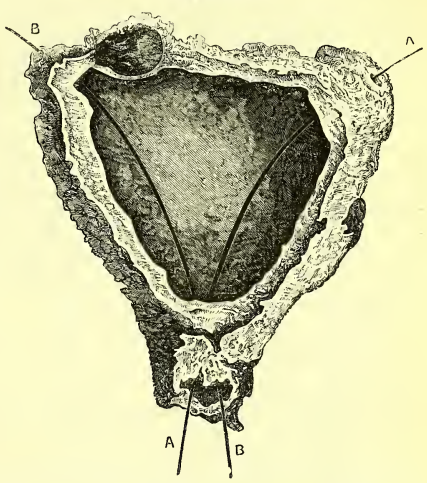
Of these two chambers, the newly formed and smaller one contains and supports the ovum, and subsequently the fœtus. It may therefore be termed the fœtal chamber; the other constitutes the original cavity of the uterus, and may be distinguished as the uterine chamber; according to the views of Breschet, it is the hydroperionic cavity. As the fœtal chamber enlarges, and the decidua reflexa becomes more expanded in consequence of the growth of the contained ovum, it gradually encroaches upon and finally obliterates the uterine chamber, which can no longer be distinguished as a separate cavity after the fifth or sixth month of gestation.

It will be necessary to examine separately the general characters of these two decidual coats. That which lines the uterine cavity may be first noticed. The parietal decidua, at the very earliest period of pregnancy in which it can be examined, forms a soft and spongy layer, 1—2‴ in thickness. That surface which looks towards the uterine cavity is elevated into numerous projections, which may be roughly compared to the cerebral convolutions, though relatively much flatter and less regular than these; between them are numerous little furrows or channels. The whole surface, both in the sulci and elevations, is covered by numerous minute perforations, corresponding with those formerly described as the orifices of the uterine glands in the unimpregnated uterus. But these orifices, from being enlarged, may now be easily distinguished by the unaided eye. They give to the surface a fine cribriform aspect. All these characters are more or less observable also in the decidua lining the uterus, in cases of extra-uterine (tubal) gestation. Along the marginal lines formed by the angles of the cavity, where the decidua is always thinnest, these apertures are large and expanded, but in the elevated spots they are often closed, apparently from lateral pressure, occasioned by the rapid growth of structure.

When early abortion takes place, the whole lining of the uterus, including the decidua reflexa, is often thrown off entire, forming a cast of the uterine cavity. If this occurs in the first fortnight of gestation, the mass retains the triangular form of the uterus. In each of the three angles is generally found an aperture corresponding with the points at which the membrane had been torn off from its continuity with the lining of the Fallopian tubes and cervix uteri.

The outer, or dorsal surface of the substance expelled, is always rugged. It exhibits numerous little papillary or club-shaped ele-

Fig. 450.



The entire decidua or lining membrane of the uterus cast off in abortion. (*After W. Hunter.*)

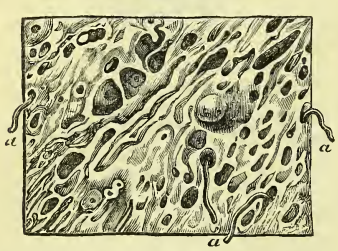
A portion of the specimen has been cut away to show the interior, which had formed the uterine cavity. The slight elevations upon this surface are very characteristic of the decidua in this condition. The outer surface is rough and flocculent. The fœtal chamber is in process of formation in the upper part of this specimen, near one of the tubal orifices. The ovum having at this time no adhesion to the walls of the chamber, has dropped out of it. Bristles are introduced at the orifices corresponding with the Fallopian tubes, and pass out at the internal os uteri, the cervix not contributing to form the decidua.

vations, and between these much smaller cup-like or conical depressions, which are seen by transmitted light to lead, where the membrane is thinnest, directly into the apertures observable on the inner surface. At the thinnest points of all, these apertures are so wide, and the cup-like depressions so shallow, that the part has the appearance of a net, the meshes of which still consist of the enlarged orifices of the utricular glands. Hence the epithet "lace-like," often applied to the decidua in this condition.

The roughness of the dorsal surface of this, the parietal decidua, is occasioned by the membrane having been torn away from its connexion with the muscular coat of the uterus, in the act of abortion. The club-like projections are apparently the bases or blind ends of the hypertrophied utricular glands torn out entire from the substance in which they were previously embedded. When laid open, they are found to contain a small cavity. The cup-like depressions are the halves, or portions of similar, perhaps smaller glands, torn across, so as to leave other portions still attached to the uterus. The meshes are simply the orifices of such glands and of the channels leading to them.

At this and subsequent stages there may be often seen lying within and among these orifices, fine, thread-like ramified filaments, which some physiologists suppose to be utricular glands, or their epithelial lining, now becoming loosened out and falling away, — a view in which my own observations do not enable me to coincide. See *fig.* 451.

Fig. 451.

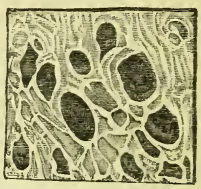


External surface of the decidua vera, from an ovum of about two months; showing the oblique channels in its substance. (*After Schrœder van der Kolk.*)

a a a, filaments supposed to be the loosened utricular glands (?)

As pregnancy advances to the third and fourth months, the uterine chamber expands, the decidua which lines it increases in thickness in parts to 3—4‴, and becomes at the same time more spongy, so that upon section it appears to be composed of flattened spaces or cells, communicating together by wide valvular orifices. These are best seen by examining under water the rough surface of an aborted ovum at that period, or the corresponding portion of the uterus from which it had been torn off. (*Fig.* 452.) These cells, or areolar spaces, continue to be seen, more or less distinctly, in the decidua throughout pregnancy, but are most conspicuous near the margins of the placenta.

Fig. 452.



Surface of the decidua vera more advanced. (*After Schrœder van der Kolk.*)

It is here represented as still attached to the walls of the uterus after the chorion, together with a layer of the decidua, have been peeled off from it. From a uterus at the sixth month of pregnancy, just beyond the margin of the placenta. The orifices and canals are much wider than in the first figure.

They are still divisions of the same ramified canals, or uterine glands, which have been described as found everywhere in the lining membrane of the uterus before impregnation, *fig.* 438., but now become so dilated and tortuous as scarcely to be recognisable as the same structures.*

In the latter months of pregnancy, the parietal decidua becomes thinner, and loses much of its spongy character, except immediately around the placenta, where this is still most distinct. It ultimately becomes blended with the outer surface of the fœtal membranes, and is partly thrown off with them in the act of birth, while a part remains, forming a honeycomb layer, attached to the uterine muscular coat.

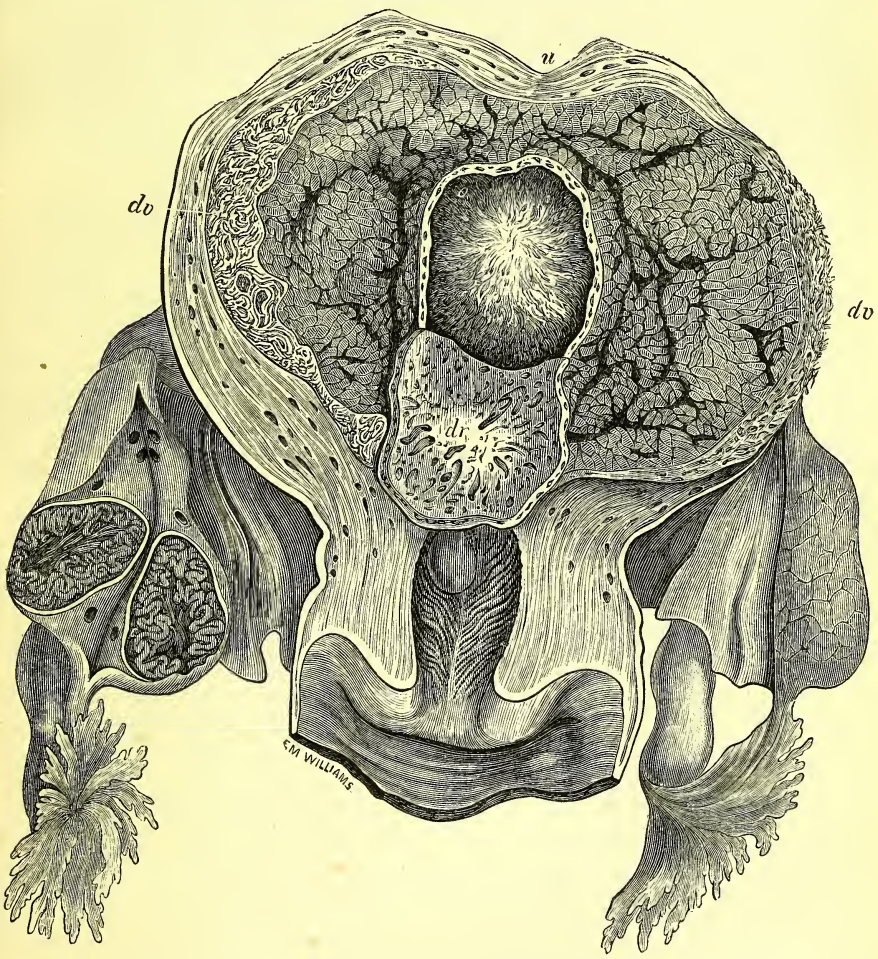
If next the growth of the *decidua reflexa*, or *decidua ovuli*, be traced, this will be found to undergo a development corresponding with that of the ovum, which it encloses and protects. The little chamber containing the ovum, which, as already stated, usually occupies a situation near one of the upper uterine angles (*fig.*450.), although it may also be found near the lower orifice (Hunter, "Gravid Uterus," *pl.* 34., *fig.* 4.), or elsewhere, appears at first like a small superadded cavity upon the outside of the larger one, or that formed by the parietal decidua. But as the development proceeds, the fœtal protrudes gradually into the uterine chamber, in the form of an incomplete sphere, whose upper pole rises free into the

* The four figures 450, 451, 452, and 453., showing the decidua or lining membrane of the uterus in different stages of development during pregnancy, should be compared with *figs.* 438, 439. and 443., which exhibit the same structure in different conditions of the unimpregnated state. These structures form a developmental series, the individual stages of which are often dislocated from their true and natural sequence by the employment of terms calculated to give an impression that the parts spoken of are different in structure and composition. "Mucous or lining membrane of the uterus," "Lymph," and "Decidua," when so employed, should be read as convertible terms representing the same part in different stages of development.

uterine cavity, but the lower forms an attached base of greater or less breadth, which is continuous in its entire circumference with the parietal decidua. The two chambers are totally distinct, and have no communication with each other. In aborted specimens, an aperture may be sometimes seen in the base or outer surface of the fœtal chamber, or that part which has been torn away from the uterine substance. In a very early specimen in my possession, and also in another which I have examined, one or more points are distinguishable also upon the upper or northern pole of the little spherical chamber, which have the appearance of apertures recently closed. Coste, in his beautiful series of illustrations*, directs attention, in several figures, to a similar spot in the same situation, having the appearance of a recently closed aperture, or umbilicus. These traces of openings in both the upper and lower poles of the sphere, are of consequence, in reference to the explanation which will be presently offered of the mode of formation of the decidua reflexa and fœtal chamber.

The outer surface of this chamber is nearly

Fig. 453.



Uterus in the first month of gestation; showing the formation of the fœtal chamber by the decidua reflexa, more advanced than in fig. 450. (*After Coste.*)

u, uterine walls laminated and traversed by numerous vessels; *d v*, decidua vera or developed lining membrane of the uterus, the uterine glands or canals being much enlarged; *d r*, decidua reflexa, in which lies *o*, the ovum, at this stage often still unattached; *c*, corpus luteum.

smooth. Upon it, however, are seen the orifices of numerous uterine glands. These are usually wanting near the centre, or umbilicus, but become more distinct towards the

* Histoire Générale et Particulière du Développement des Corps Organisés.

circumference, and are very numerous, large, and close set, in the decidual fold at the base, all round the line of apparent reflexion.

Numerous flat vessels, obviously veins, terminating in minute subdivisions, are seen ramifying over the whole surface, but becoming very scanty, or ceasing near the central point. They are continuations of similar vessels, which are still more conspicuous upon the parietal decidua. The capillaries in which these vessels terminate are exceedingly numerous, and may be sometimes seen deeply injected with blood. This is rendered the more conspicuous when the congestion is unequal, so as to form patches of a bright pink, alternating with other portions of a pale flesh colour.

The internal surface of the fœtal chamber, after the ovum has fallen out, or has been removed, presents a slightly uneven appearance, occasioned by numerous very shallow pits or depressions, occurring in close-set groups, and resembling, upon a small scale, the areolæ upon the inner surface of the heart.

When the body of the embryo begins to acquire length, the entire ovum exchanges the spherical for the slightly oval form, and to this the fœtal chamber also becomes adapted. Such is found to be the form of the fœtal chamber, sometimes in the latter half of the first, but generally during the second month, and from this period onwards the ovate figure prevails.

In the latter part of the first month, or at latest in the beginning of the second, the ovum, previously lying loose in the fœtal chamber, begins to be attached to the walls which surround it. This attachment is effected by the extremities of the villi, which from the first equally surround the chorion, everywhere becoming attached to the little pits and anfractuosities upon the inner surface of the fœtal chamber just described. In this way the embryo, surrounded by its amnion and chorion, becomes securely anchored in the midst of its little chamber, through the instrumentality of the villi, which, spreading in all directions, may be compared to the rays of the geometric spider's web.

Thus to receive, to protect, and support the ovum, and to prevent its escape from the uterus, appears to be the first object of the formation by the reflected decidua of a separate fœtal chamber (*fig.* 453.).

Ultimately, as the ovum grows, the base of its chamber expands, and here takes place a more dense and rapid growth of decidua. This is the part commonly termed the *decidua serotina*. Here the chorion villi, which now form large ramified groups, attach themselves, and from the margins of the collections of sulci just described, into which the villi penetrate, and which are now much extended, there proceed offsets or dissepiments of decidual structure. These dip down between the groups of villi sometimes as far as the surface of the chorion, and divide that which was formerly one continuous collection of ramified chorion fringes, into the separate lobes which characterise the mature placenta.

One or two points remain to be more explicitly stated. It may be asked, how does the ovum gain the interior of the fœtal chamber, or, in other words, how is the decidua reflexa formed around it? In reply to this, little beyond conjecture can be offered. Of the numerous explanations which have been attempted, few are found to meet all the peculiarities of the case. It is most probable that either the ovum becomes embedded in some of those folds of decidua which are found in it at an early period of pregnancy, and so the decidua becomes built up around it, as Sharpey and Coste suppose. Or, as it appears to me more likely, the ovum, on first reaching the uterine cavity, drops into one of the orifices leading to the utricular follicles, and in growing there draws around it the already formed, but soft and spongy decidua constituting the walls of the cavity. The chief support for such a conjecture, beyond its apparent probability, is the fact ascertained by Bischoff, who, in one case in the guinea-pig, found the ovum in precisely this situation at the bottom of a uterine follicle.*

The entrance of the ovum into the decidua being supposed, the rest of the growth of the reflexa is easily followed. The ovum now, in enlarging, raises the walls of the chamber, in which it lies, just as the skin becomes raised by the accumulating contents of a subcutaneous abscess. The process is probably in part purely mechanical, and in part in the nature of an excentric hypertrophic growth; for the actual substance of the chamber is much increased beyond the material of which it was at first composed. That some of this is borrowed from the parietal decidua, is very probable from the number of orifices of utricular glands seen upon its surface, which serve to show that the decidua reflexa is so far formed out of pre-existing structures; but much is also due to the further development of the elemental decidual tissues; and to the growth of these, the large vascular supply, which the reflexa at first receives, doubtless contributes. The little point, or umbilicus, observed sometimes at the upper pole of the fœtal chamber, may mark the spot at which, upon either of the foregoing hypotheses, the ovum first entered the decidua.

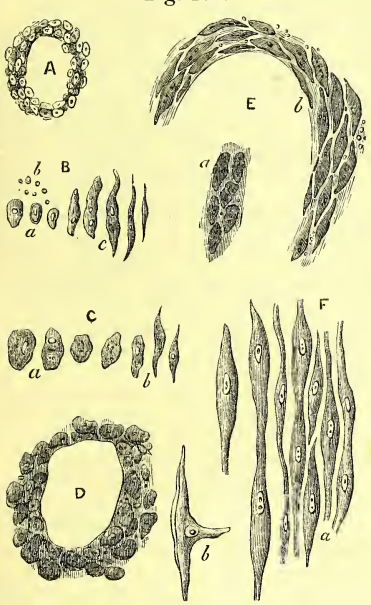
Another question which has never been satisfactorily determined, relates to the ultimate fate of the decidua reflexa. Dr. Hunter, from observing that, at the time of birth, only one layer of decidua can be found upon the secundines, supposed that, after a certain period of pregnancy, the decidua vera and reflexa, having come into contact, united to form one membrane. Doubting this explanation, I have made many observations, with a view to settle this point; and from these I

* While these sheets are passing the press, I have received the last part of Otto Funke's "Lehrbuch der Physiologie," 1857, in which the same suggestion is offered, exemplified by the same case, which, indeed, is the only one yet known.

am satisfied that no such union takes place; but that, when the decidua reflexa has fulfilled the offices already assigned to it, and has ceased to be vascular, so that no further addition of material to it can take place, it becomes, after the fifth or sixth month, so completely attenuated by distension from the growth of the ovum within, that it is reduced to a mere film, of which the only trace left at, or indeed before, birth, is a narrow frill still discoverable at the margin of the placenta between the decidua vera and the chorion. But the decidua lining the uterine walls continues vascular to the last; and this alone constitutes the membrane a part of which at birth is found adherent to the outer surface of the chorion, and which Dr. Hunter, from observing that it now consisted of only one layer, imagined was formed of the two deciduæ united together.

Histology of the decidua. — The morphological changes effected during pregnancy in the decidua, and the chief purposes of these, having been stated, the histological peculiarities will now be briefly described. The lining membrane of the uterus, from infancy onwards, is composed, as already shown, of free elementary corpuscles or nuclei, contractile fibre cells, amorphous tissue and epithelium, together with capillary vessels, and the tortuous canals termed uterine glands. These undergo important modifications, which serve to explain the great and rapid growth of the decidua during pregnancy. According to Schrœder van der Kolk, who has traced and figured with great care the several stages of development of these elemental tissues, the cells of the decidua, surrounding an ovum of about three weeks, situated nearest the villi, have already undergone considerable enlargement. These occurred in the form of oval nucleated cells (*fig.* 454. *B a*), with fine nuclei and fat granules, *b*, intermixed; while in the layer of the decidua, still deeper, occurred longer cells, that were already beginning to form fibres.

Fig. 454.



Histology of the decidua. (*After Schrœder van der Kolk.*)

A, orifice of utricular gland of an unimpregnated adult uterus surrounded by round epithelial cells; E, cells of decidua in an ovum of about three weeks; *a*, round and oval nucleated cells; *b*, fat granulations; *c*, cells, from a deeper layer, elongated and beginning to form fibres; C, the same from an ovum of five weeks; *a*, round and oval cells, much enlarged, and containing nuclei and fat granulations from the surface; *b*, elongated cells from a deeper layer; D, orifice of a utricular gland from the same ovum, much enlarged as compared with A; E, margin of a valvular opening in a deeper layer of the decidua, from an ovum of two months; at *b*, the cells have become elongated, at *a* they are filled with fat granulations; F, long and broad cells from a decidua of nine months; *a*, the cells exhibit a nucleus, some having one and others two nucleoli; *b*, three-pointed cell.

In an ovum of five weeks, similar cells were found, in a further stage of development. In the superficial decidual layers, the oval cells, *C a*, were filled with granules, and contained a nucleus, and some a nucleolus. In the deeper layers, as before, the cells had become more elongated, *C b*. In and between all these cells were numerous minute fat granules, and among the cells lay fine nuclei. The openings of the utricular glands, *D*, which were surrounded by enlarged epithelial cells, were now considerably expanded, as compared with their usual condition previous to impregnation, *A*.

At two months, the increase in size of the oval cells, *E a*, now abundantly furnished with fat granules, was still more marked. These were developed into long cells, *b*, which were found composing those valve-like membranous septa formed now everywhere on the deeper decidual layer, as already described, *fig.* 452.

From this period onwards, the development of the cells proceeds more and more rapidly, until those in the deeper layers become transformed into fibres, which it is impossible to distinguish, under the microscope, from the peculiar contractile fibre cells of the true muscular structure.

In the ninth month are found colossal fibre cells, *F a*, which are rarely seen beyond the margin of the placenta. These were very transparent, and exhibited, some one, and some two, nucleoli. A remarkable three-pointed cell is sometimes also observed, *F b*. Fibres of fibrous tissue occur everywhere, and between them small cells and nuclei. The utricular glands have long ceased to be discernible in the advanced stages of pregnancy.

According to the observations, however, of Rolin, Robin, and Kilian, from the fourth or fifth month onwards, the decidua begins to lose the character of energetic life, which, up to that period, it had exhibited, and becomes atrophied, and less firmly adherent to the

uterine walls; while, between it and the muscular parietes, there appears a new formation of decidua, at first soft and delicate, but which gradually acquires the peculiar characteristics of that membrane. This layer is not thrown off at birth, nor dispersed in the lochia, but remains attached to the inner uterine surface, and forms the foundation of the new mucous membrane, with which, after labour, the uterus is furnished. M. Robin supposes that this new soft layer is often mistaken for a product of inflammation occurring in puerperal and other uterine maladies.

e. The uterus after parturition.

Immediately after labour, the uterus, if entirely empty, occupies the whole of the pelvic cavity, together with the lower portion of the hypogastric region. The bulk of the organ varies in different individuals, and is considerably greater after twin or multiple pregnancy.

The tissues generally are of a redder colour, and softer, and more easily lacerable than in the unimpregnated condition; those of the cervix being usually more lax than those of the body, from infiltration of serum, and occasionally, in parts, of blood.

The cervical mucous membrane, which is retained*, after labour exhibits here and there sometimes slight lacerations, extending occasionally into, or through, the proper tissue of the part. In other respects, the internal aspect of the cervical canal resembles that of the same part in the last month of gestation, except that the large and voluminous plicæ (*fig.* 446.) have become folded out and flattened during the previous act of labour. Around the margin of the internal os uteri may be seen a thin ragged fringe marking the point from which the decidua, here usually much attenuated, had been torn away.

The entire uterine cavity is denuded; it presents everywhere, except at the placental space, a rough, flocculent, and sometimes honeycomb-like surface, caused by the detachment of a portion of the decidua and its discharge along with the fœtal membranes. Another portion remains covering the muscular structure of the uterus, but is in parts so thin, that the latter appears to be left nearly bare.

The surface to which the placenta had been attached forms usually one-third of the entire inner superficies of the contracted uterus. This, which is termed the placental space, is easily distinguished by its uneven, rugged, and somewhat nodulated appearance; caused chiefly by the presence of numerous large veins, whose truncated orifices obstructed by coagula here protrude slightly above the general level.

Upon section, the uterine walls exhibit everywhere the same laminated arrangement of the proper tissues, with numerous intermediately lying tortuous arteries and flattened veins and sinuses, already described as observable in the uterus during the latter periods of pregnancy (*fig.* 449.).

These flattened thin-walled veins are usually empty, or contain a few unadherent coagula. Those, however, which occupy the seat of attachment of the placenta, where they are much larger than in any other situation, are filled with dark or greyish-red clots adherent to their walls, and closing their mouths, which terminate directly upon the uterine cavity.

The peritoneal coat of the recently emptied uterus is of a pale pinkish-white colour, and presents a smooth, shining, and in parts a slightly wrinkled surface. It is thicker and less diaphanous than the same membrane before labour.

The process of involution. — No rapid or material alteration in the size or composition of the organ occurs during the first few days after labour. In the course of the first week, however, commences a series of important and interesting processes, continued during the greater portion of the two months immediately following labour, and having for their object the restoration of the uterus to a condition similar to, though not identical with, its state before impregnation. These changes consist in a gradual diminution in the weight and dimensions of the organ accompanied by a corresponding metamorphosis and ultimate reconstruction of its tissues. They together constitute the process commonly termed the involution of the uterus, which will now be examined.

Changes in dimensions and weight.—According to repeated estimates made by Heschl, the weight of the uterus, immediately after labour, ranges from 1 lb. 6—7 oz., ordinarily, to 2 lbs. 5—7 oz.; the latter being the weight after twin labour.

The dimensions depend upon the degree of contraction. Under ordinary circumstances, the entire length is 8—10 inches, and the thickness of the parietes 1 inch. These first changes in the dimensions of the organ, as compared with the state previous to labour, are effected solely by the contraction of the uterine fibre. They consist chiefly in a rearrangement of relative position in the component tissues, by which, while the entire substance of the uterus remains undiminished, its length and breadth are greatly reduced, and the thickness of the parietes correspondingly increased. In one respect, however, the entire bulk and weight are less than they were before labour, because a much smaller quantity of blood now circulates in the walls, but the solids remain unaltered.

At the end of the first week, the diminution of the organ is not very considerable. Its weight is merely reduced from 1 lb. 6—7 oz. to 1 lb. 3—4 oz. At the end of the second week, the rate of diminution is found to have been much more rapid; the organ now weighs only 10—11 oz. At the end of the fifth week, 5—6 oz.; and in the course of the second month, it is reduced to its ordinary weight of 1½ to 2½ oz.; but it never entirely regains the

* For the discussion of this question, see the works of Heschl, Robin, and Kilian, hereafter quoted.

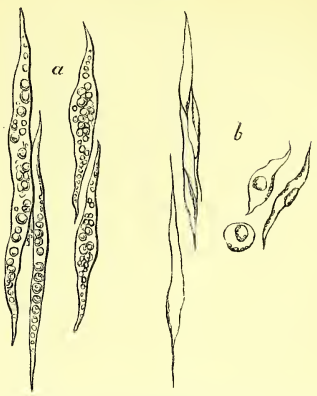
small size and dimensions characteristic of the virgin state.

Metamorphosis and restoration of the component tissues. — The first and immediate reduction in size of the uterus, after parturition, has been just stated to depend upon mere contraction of the uterine fibre. But contraction alone will not account for those great and remarkable reductions in the dimensions of the organ which have been just described. The true explanation of these phenomena is furnished by a series of metamorphoses affecting more or less the entire uterine tissues, by which the greater portion of those structures which have been formed during pregnancy, become disintegrated and removed, while other and new tissues are developed in their place.*

In these metamorphoses, the colossal fibre cells, which form the great bulk of the newly added material, play the most important part. These have been traced, during their development in pregnancy, from the small fusiform cell of the unimpregnated uterus to the fully formed fibre of the organ at term. The growth of these proceeds *pari passu* with that of the fœtus, for whose expulsion they are destined; and this act being accomplished, their destruction and removal becomes a necessary prelude to the recomposition of the entire organ upon the same type as before impregnation. In this respect, the aggregate formation of fibre cell is comparable to the deer's horn, the placenta and other structures which, having served the purpose of their formation, and being incapable of suffering retrogression, become caducous, with this difference, however, that the one class of structure being thrown off in a mass, the act of separation is striking and obvious; while the deciduous process in the other is gradual and fragmental, and can only be discovered by the most patient and careful scrutiny.

The disintegration and removal of the uterine muscular fibre is effected, first, by the transformation of each fibre into molecular fat. This process does not commence earlier than the fourth or sixth day after labour, and not later than the eighth day. Certain differences are observable in the order of retrogression. Thus the process begins somewhat later in the inner than in the outer laminæ, while the cervix remains unchanged a few days longer than the body. In the individual fibres, the process of decay begins at many points simultaneously. The fibres lose their sinuous outline, and become paler; while within them appear yellow oil granules, commonly arranged in rows. The nucleus of the fibre is pale, but distinct, until it becomes obscured by the increase of the oil granules; while the extremities of the cells, on account of their tenuity, are the first to suffer disintegration.

Fig. 455.



Process of involution or disintegration, and renewal of the uterine fibre after parturition. (*After Heschl.*)

a, the old fibres filled with fat granulations 2 — 4 weeks after delivery; *b*, development of new fibres in different stages, about the fourth week.

During the second and third week, the process of disintegration continues; and it is probable that a considerable absorption of effete material now takes place, since it is not easy to explain otherwise that rapid diminution in bulk, especially in the second week, which the entire organ undergoes, as shown by the calculation of weights already given. As a result of these molecular changes, the uterus now loses its reddish colour, and becomes of a dirty yellow, and is at the same time more easily lacerable.

In the course of the fourth week, and possibly sometimes during the third, there appears, in the midst of the now degenerated fibres, the first traces of a new formation of uterine substance. These occur first in the form of cell nuclei, which are concurrently developed at several points; and gradually, while the last portions of the old muscular coat are being disintegrated and absorbed, acquire the character of the new muscular fibre cells (*fig.* 455. *b*). So that, by the end of the second month, the reconstruction of this portion of the uterine substance is often complete.

The disintegration of the remains of the decidua, and the reconstruction of the lining membrane of the uterus, which had been removed during the act of birth, is effected by a process very similar to that just described.

With regard, first, to that portion of the inner uterine superficies, which had been covered by the placenta, it is observed that this undergoes a somewhat slow retrogression. The veins, filled by thick clots in the normal state in consequence of the progressive involution of the intermediate uterine substance, occasion here a marked protrusion; so that very often, after four or six weeks, the placental space forms an elevated spot of twice

* On this subject the following may be consulted with advantage: — Dr. R. Heschl, "Untersuchungen über das Verhalten des menschlichen Uterus nach der Geburt," in the Zeitschrift der kais. kön. Gesellschaft der Aerzte zu Wien. 1852. B. ii. p. 228.; F. M. Kilian, "Die Structur des Uterus bei Thieren," *loc. cit.*; Schroeder van der Kolk, *loc. cit.*

the circumference of a dollar. Finally, however, these coagula are removed, and, together with the veins, disappear, while the place sinks to the level of the surrounding parts; and, after becoming smooth and receiving an investment of mucous membrane, is generally no longer discernible. The restoration of the placental space to its former condition does not, however, always proceed normally. Sometimes, in consequence of excessive activity in the process of reconstruction, hypertrophic growths of the new material take place; so that, several months after labour, a tumour of more or less considerable size, formed at the expense of the uterine tissues, is found to occupy the original seat of the placenta. I have satisfied myself by several microscopic examinations of the correctness of Heschl's opinion, that in this way are formed some of those anomalous-looking fleshy substances which are occasionally discharged from the uterus, and are regarded as moles.

The *histological* changes, which take place after labour in the tissues lying internally to the muscular coat, up to the complete restoration of the mucous membrane, have been examined by many observers, not always, however, with corresponding results. It appears certain that a portion at least of that layer of decidua which is still left attached to the uterine walls, is removed by fatty transformation, and that many of the products are discharged by the *lochia*. Schrœder van der Kolk has traced this process as it occurs in the nuclear cells and fibres, which form so large a portion of the decidua. Those very broad fibre cells, which are visible in it up to the ninth month of pregnancy, are no longer to be found four or five days after labour, when they appear to be transformed into long cells, through an abundant fatty transformation which progressively continues, until, by the increasing development of the oil granules and the corresponding diminution of the cells and fibres, the situation of the latter can ultimately only be discovered by the still existing longitudinal direction of the fat nuclei, while all traces of a cell wall have entirely disappeared.

Without the aid of the microscope, however, it may be seen that, a few days after labour, the entire inner surface of the uterus is covered by a more or less red soft pulpy substance, which has the same anatomical composition as the decidua. This, which is considered by some physiologists as identical with the layer of decidua already described, as formed, according to Kilian, Robin, and others, as early as the fourth or fifth month of gestation, is not discharged after labour, but becomes the seat of that reparatory process, by which the restoration of the mucous membrane upon the uterine body is effected. Between the twentieth and thirtieth day, this layer begins to resume the character of a mucous membrane. It is at first more pulpy, and softer, and thicker than mucous membrane in a normal state. The vessels become distinct in it about the third week, and sometimes still later. Previous to this, the blood appears to be contained in simple channels between the elongating cells.

The epithelium is as yet hardly formed. By scraping the inner surface of the uterus twenty days after labour, Schrœder found still only the remains of half decomposed cells. But no new cells with cilia could be yet with certainty discovered.

The utricular glands make their appearance last of all. In several cases, Heschl found them completely formed at the end of the second month; but previous to this, their development could not be traced.*

Finally, it may be said that the restoration of the mucous membrane, with all its peculiar structures, is completed about the sixtieth or seventieth day after delivery, *i. e.* by the time that the uterus is reduced to its normal bulk.

Thus it appears, that the act of involution consists in two processes, which are concurrently performed, yet with opposite purposes. For the act of reconstruction being commenced long before the retrograde metamorphosis is complete, the result of both is, that a restitution or reconstruction of certain tissues of the uterus, more or less complete, takes place.

With regard to the muscular coat, it is perhaps not any overstatement of the fact to say that each ovum is provided with its own series of fibres for the purpose of effecting its expulsion, and that these, after parturition, entirely disappear, or at least can no longer be recognised, while a new series of embryonic or undeveloped forms appears in their place. The same may also be said of the decidua, though with certain differences as to the time and mode of its destruction and renovation. Regarding the fibrous tissue of the uterus, little has been determined with accuracy; but enough has been observed to render it probable that this also, to a certain extent, becomes subject to fatty transformation. The blood-vessels appear to be likewise partly involved in a similar process, although their principal trunks probably suffer but little change beyond a material diminution of size. The peritoneum is that tissue which undergoes the least apparent alteration. It preserves, however, a thickness proportionate to the reduced bulk of the organ, and consequently it must suffer a corresponding involution.

Regarding the puerperal alterations in the nervous system of the human uterus, but little is known. Kilian†, after examining a specimen at eight, and another at twelve days after labour, as well as the uterus of many animals at different periods, arrived at no definite conclusions. He thinks it in the highest degree doubtful, that, in the puerperal state, the nerve fibres undergo the same involution process as the other tissues; viz. that the old fibres are entirely destroyed, and become replaced by a new, younger, or embryonal

* By Kilian they are said to be formed during pregnancy.

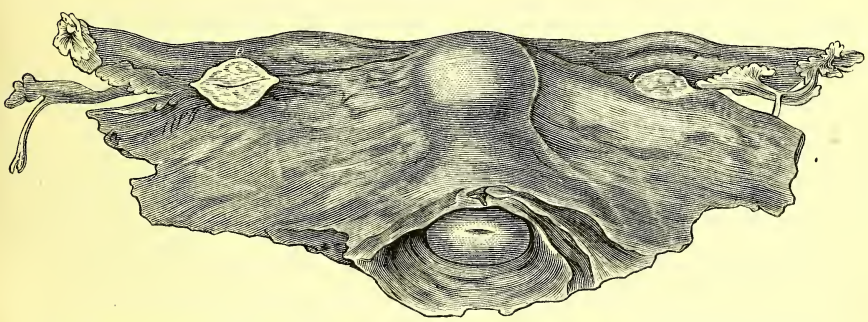
† *Loc. cit.*

form. He rather conceives that a reduction so takes place, that either the contents of the nerve fibre are partly or entirely removed by resorption, so that there remains, according to circumstances, a partly or entirely empty sheath; or that the contents of the fibre are transformed in the same manner that Günther and Schön (Henle, Allgemeine Anat. p. 771.) observed in divided nerves; viz. that the contents of the tubules become coagulated, as after death, and are then subject to resorption: the fibre appearing then to be perishing, and ribbon-like, and the contents to be disappearing. Regarding the human uterus, he thinks it in the highest degree probable, that the nerve fibre is included in the energetic resorption process that affects the puerperal uterus generally; that a reduction of the fibre follows; and that, in the next pregnancy, it again becomes developed *pari passu* with the development of the other tissues.

f. The uterus after the menstrual epoch, and in old age. — Whether the uterus has been employed, in its ultimate office, in the process of reproduction, viz. that of gestation, or whether it has proceeded only so far towards this as to have been limited to the repetition, in unvarying succession, of that preparatory stage which is expressed by the minor function of menstruation, in either case the period equally arrives at which the activity of the organ passes away. Ova are no longer discharged from the ovaries. These cease to be creative or developing organs; and with this cessation of the proper function of the ovary, there comes also a corresponding diminution, and finally a termination of the correlative offices of the uterus.

It is now interesting to observe how the uterus gradually resumes some of the peculiar features which it exhibited at an earlier period of life. It may be said to fall back again into its infantine condition. For with the shrivelling of the ovaries, and their reduc-

Fig. 456.

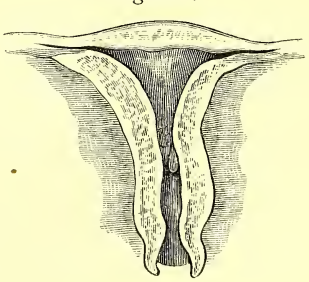


The uterus in old age; showing a return to the infantine proportions between the body and cervix.

o, the shrivelled ovaries.
This figure exhibits the parts of half the natural size. (*Ad Nat.*)

tion to a size as small sometimes as that of a child of two or three years, (*fig.* 456.) the uterus also gradually shrinks, not in all its parts, but principally in the body, or that portion which is chiefly employed in the processes of menstruation and gestation. This part becomes atrophied more than the rest; its walls become thinner, partly from diminished circulation in them, and partly from atrophy of the component tissues, which appear pale and nearly bloodless. Thus it happens that, in advanced life, the walls of the uterine body, no longer possessing that fulness which at an earlier period caused them to encroach upon the cavity, and to exhibit that incurvation of the sides and fundus which has been described as characteristic of the mature organ, again return to the straight and more attenuated condition which they had in early life. We may often observe, therefore, in the uterus of aged persons, a nearer approach to the form of the equilateral triangle, caused by the shortening of the body and the straightening of its walls, than is seen in the uterine cavity of mid-life; and it is this return to the form of the fœtal cavity, together with the now preponderating size of the cervix, which remains

Fig. 457.

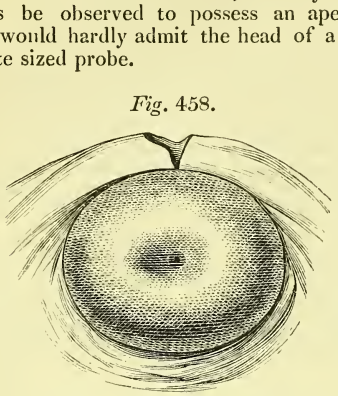


Thinning of the uterine walls in old age, and return to the triangular form of the cavity characteristic of the infantine (*fig.* 442.) *and undeveloped uterus* (*fig.* 465). (*Ad Nat. Half the natural size.*)

nearly unchanged, that gives to the aged uterus its greatest similitude to that of infancy or early youth.

But these changes are not limited to the body of the uterus. The external uterine orifice being now no longer required to serve as a conduit for fluids to or from the uterus, or for the passage of more solid contents, becomes reduced in diameter, and may sometimes be observed to possess an aperture that would hardly admit the head of a moderate sized probe.

Fig. 458.



Os uteri in old age. (*Ad Nat.*)

Functions of the Uterus.

The uterus, in common with the rest of the generative organs, being concerned only in the reproduction of the species, its offices are limited to that period in which the animal functions are maintained in their highest state of efficiency. The growth of the body is nearly or quite completed before the sexual offices commence, and the power of reproduction continues as long as the frame is maintained in full vigour; but when the age arrives at which the animal functions generally begin to decline, their decay is anticipated by the total cessation of the power of procreation in the female. The period, therefore, is limited, yet not brief, during which the functions of the uterus can be exercised, and on either side of this epoch the organ remains passive, except under abnormal states.

The chief functions of the uterus are those which relate to — 1. Menstruation; 2. Insemination; 3. Gestation; 4. Parturition.

The office of the uterus in menstruation. — Although the uterus is the efficient instrument in the performance of menstruation, yet the power of initiating and regulating this function resides in the ovaries, which exert a powerful reflex influence, not only upon the uterus, but also upon the entire organism. Without the ovaries, menstruation has never been known to occur. Their artificial removal is followed by a permanent cessation of the catamenial flow, although the uterus may be left uninjured; while the congenital absence of both ovaries is always accompanied by an enduring amenorrhœa.

The external sign or evidence of menstruation consists in the occurrence of a sanguineous discharge, which escapes from the vaginal orifice of women in health, periodically, except during pregnancy and lactation. This discharge first appears usually between the fourteenth and sixteenth years, and continues to be repeated at intervals of a lunar month for an average period of thirty years. The time, however, of the commencement, as well as of the decline, of menstruation is very variable, and may be either much accelerated or retarded, according to individual peculiarities.*

Periods of duration and recurrence. — The catamenial period and interval together occupy a space of one lunar month. And in some women this function is performed with such regularity that the day, and very nearly the hour, of its expected return may be predicted. The natural duration of the flow varies from three to five or even seven days. An interval then occurs during which the flow entirely ceases. This occupies from twenty-one to twenty-five days; and it is during the first half of this interval that conception most commonly takes place.

It cannot, however, be asserted that this degree of regularity is observed even in the majority of women. Frequently the period of regular return is anticipated by one or more days; or, on the other hand, it may be retarded, without the occurrence of any concomitant disturbance of other functions, such as would justify the regarding of these examples as abnormal. But whatever may be the amount of variation — dependent in most cases upon idiosyncrasy, — still a law of periodicity is observed which, in all ages and countries, has been recognised, and more or less distinctly expressed by such terms as catamenia, menses, courses, periods, règles, mois, monatlicher Fluss, and the like.

No catamenial discharge takes place normally during pregnancy or lactation. Exceptions to both these rules, however, occur, and instances of the latter are sufficiently common. But with regard to the former, it is probable that many at least of the recorded cases of menstruation during pregnancy have been cases in which the placenta was implanted low down, or even over the os, under which circumstances it is well known that slight flooding will occasionally commence at an early period of gestation, and observe a certain rough periodicity. Upon *anatomical* grounds, a catamenial flux during pregnancy can only be supposed possible where the condition of the uterus is such as to admit of the discharge taking place from the vaginal portion of the cervix; an occurrence which is shown by Mr. Whitehead to have obtained in all the instances of supposed menstruation during pregnancy which he had investigated. For "on examining these cases with the speculum

* For much valuable statistical information relating to the periods of invasion and decline of the catamenia, and in refutation of the popular belief that these periods are greatly influenced by climate, &c., see Robertson's Essays and Notes on the Physiology and Diseases of Women; also, on the subject of menstruation generally, Whitehead, the Causes and Treatment of Abortion and Sterility; A. Brierre de Boismont, De la Menstruation, 1842; Raciborski, De la Puberté, 1844.

during the existence of the menstrual phenomena, the blood was invariably found issuing from diseased surfaces situated upon or about the labia uteri, none escaping from the interior of the organ." *

But in any case there is wanting a sufficient series of observations, taking cognisance of the exact duration and times of recurrence of such discharges, and comparing these with the normal periods and intervals of menstruation, to warrant an unhesitating belief in the occurrence of a true catamenial flow as a possible phenomenon during gestation.

Quantity. — The quantity of the menstrual fluid which escapes at each period has been so variously estimated at different times and by different observers, as to render it obvious that the calculations could not have proceeded upon any common data. Thus Hippocrates, and afterwards Galen who quotes him, states the quantity as two Attic hemina, equal to about eighteen ounces. In recent times it has been estimated by Magendie at several pounds, and Haller gives the average amount as varying from six to twelve ounces. But all these estimates are too high. Dehaen, who employed an ingenious method of measurement, calculated that some women lost three, others five ounces, and very few half a pound ; but that it was exceedingly rare for a woman who had no malady to lose as much as ten ounces.† Probably the only proceeding by which any definite result can be obtained, is that of observing the rate of escape of the discharge from the uterine orifice. According to the observations of Mr. Whitehead, this is generally so slow that no more than from ten to twelve grains could be procured during the time that the patient was able to endure the irksomeness of the proceeding. From these, and similar observations of my own, as well as from other estimates, I conclude that two to three ounces is probably the full extent of the natural flow, and that a discharge amounting to six or more ounces in the aggregate will generally produce for the time sensible effects upon the constitution, such as general pallor, and some feebleness of the muscular system.

Nature of the catamenial discharge. — There is no foundation for the belief once so prevalent, and even partially still retained, that the menstrual fluid contains materials of a noxious or poisonous nature, nor yet that it serves as a vehicle for the depuration of the blood of the female. The occasional fœtid odour of the discharge, and sometimes also of the breath of women during menstruation, arises from the decomposition of the fluid, as it slowly collects in the vagina, and doubtless also from its partial resorption into the system, producing in such cases a heavy or fœtid odour of the breath, the cause of which was pointed out more than two centuries ago by De Graaf.‡ The menstrual fluid has always, even in health, a peculiar and somewhat heavy odour which is as characteristic of it, as is the *gravis odor puerperii* of the lochial and other discharges in childbed.* But these circumstances afford no evidence that the excretion is, when first formed, necessarily unhealthy.

The menstrual fluid, when first formed, appears to consist almost entirely of pure blood ; but, in its course through the vagina, it receives in addition the secretions of that canal, whereby both its physical condition and chemical constitution are materially altered. Hence the differences of opinion which have so long prevailed regarding the real nature of this fluid, and the extent to which it differs from pure blood. These differences have been maintained chiefly by the well-known fact that menstrual blood seldom coagulates, and also by the difficulty of discovering fibrine in it. But a solution of this difficulty is found in the fact that the mucus of the vagina has always an acid reaction, and that in this acid the fibrine of the blood is so readily dissolved, that not only is its coagulation prevented, but chemical analysis fails usually to reproduce more than a trace of it.

The menstrual fluid, therefore, as escaping from the vaginal orifice, and that collected from the os uteri, are essentially two different products, and this distinction should be observed in all examinations having reference to its chemical or physical composition. But it would be perhaps arbitrary to designate either of these alone the menstrual fluid. Probably this term is most suitable to the first. Both the vagina and uterus are concerned in the production of this fluid in the form in which it is most familiarly known, and in this form it may first be examined, the pure and unmixed product of the uterus being reserved for subsequent consideration.

Composition of menstrual fluid according to M. Denis.

Water - - - - -	82·50
Fibrine - - - - -	0·05
Hematosine - - - -	6·34
Mucus - - - - -	4·53
Albumen - - - - -	4·83
Oxide of iron - - - -	0·05
Osmazome and cruorine, of each -	0·11
Salts and fatty matter - - -	1·59

Microscopic examination. — The menstrual flux exhibits three periods or stages; viz. the periods of invasion, stasis, and decline. In the first the discharge is of a paler colour, and sometimes consists mainly or entirely of mucus — *menstrua alba.* But this stage is not always observed, the discharge often commencing at once of the deep red colour characteristic of the middle stage. This continues during the greater part of the period, and is succeeded by the third stage or that of

* Whitehead, loc. cit. p. 24.
† Brierre de Boismont, op. cit. p. 68.
‡ De Mul. Organ. Lug. Bat. 1672, p. 134.

* Doubtless this led Pliny to draw up that dire catalogue of evils, in which he informs us, that the presence of a menstruating woman turns wine sour; causes trees to shed their fruit, parches up their young shoots, and makes them for ever barren ; dims the splendour of mirrors and the polish of ivory; turns the edge of sharpest iron; converts brass to rust; and is a cause of canine rabies.—C. Plinii, Nat. Hist. liber vii. § xiii. ed. Cuvier, 8vo. vol. i. Paris, 1827.

decline, when the discharge loses its deep red colour and assumes the hue of water in which raw flesh has been washed. This is very commonly the condition of the discharge during the last day or two of each period, especially in those women in whom the flow is of long continuance.

M. Pouchet* has examined with great care the menstrual discharge at each of these periods. The following are the results of his observations: 1*st invasion.* A very few blood globules mixed with mucus may be observed, together with mucous-corpuscles and scales of epithelium, mostly entire, floating in an abundance of limpid fluid. Almost all the mucous-corpuscles contain smaller globules or granules which form in them a central nucleus. 2. *Stasis.* Menstruation having reached its apogée, the blood-globules are much more numerous than at the onset. The plates of epithelium usually remain entire. 3. *Decline.* The fluid contains the same substances, and presents nearly the same appearances as at the time of commencement of the flow.

These observations agree generally with my own, and also with those of Donné, who found the menstrual fluid to consist of, 1. Ordinary blood-globules of the proper character, and in great abundance. 2. Mucus from the vagina mixed with epithelial scales. 3. Mucous-corpuscles from the cervix uteri.

The unmixed menstrual fluid.—But in order to determine the nature of the menstrual fluid as it issues from the uterine orifice, unmixed with the secretions of the vagina, it must be collected by a speculum accurately fitting the uterine neck. The fluid so obtained possesses properties very different from those of the flux already described. Its sensible characters, as observed in more than a dozen specimens, are well described by Mr. Whitehead. Thus procured, the fluid is never so dark in colour as ordinary menstrual blood, so called, nor so fluid always as that of the arteries. Its colour varies slightly, but whatever is its tint, this is not subsequently affected by intermixture with the vaginal mucus. It appears usually rather more viscid than systemic blood, probably on account of its slow exudation. When thus collected it invariably coagulates, the separation into clot and serum being complete in three or four minutes. It sometimes passes off in a continued stream as pure blood, but more often as a thin coloured serum mixed with small flattened clots, the size of orange seeds, which, becoming broken down and, as it were, dissolved in the vaginal mucus, appear at the external orifice in the usual uncoagulable fluid form. It is invariably alkaline.

In menorrhagia the discharge is as fluid as arterial blood, and not being delayed on account of the greater rapidity of escape, it trickles in drops along the tube.

On account of the great difficulty which is experienced in obtaining the pure fluid from the uterus in quantities sufficient for chemical analysis, the following results by Bouchardat are the more valuable. The woman, a multipara, was thirty-five years of age. To explain the large proportion of water Bouchardat states that she had subsisted chiefly on a vegetable and milk diet.

Bouchardat's analysis of pure menstrual blood.

Water	90·08
Solid matter	6·92
The solids were composed of—	
Fibrine, albumen, colouring matter	75·27
Extractive matter	0·42
Fatty matter	2·21
Salts	5·31
Mucus	16·79
	100·00

It will be observed that the proportion of fibrine is here much larger than in the former example. But chemical analysis is not needed to show that this element of the blood constitutes a part of the fluid exuded from the uterus. For in women who have died menstruating fibrinous clots have been found in the uterine cavity; coagula have also just been described as forming at the os uteri and mixing with the fluid collected by the speculum, and it cannot have escaped observation that clots sometimes form about the vulva, at times of menstruation, especially when the discharge is freer than usual.

But the notion that the menstrual discharge differs from ordinary blood "in containing only a very small quantity of fibrine, or none at all,"* which view has gained general currency of late, and in support of which the investigations of Brande or Lavagna are usually quoted, appears to be altogether a modern one. For the older writers considered the menstrual discharge as identical with blood. Hippocrates says in reference to it, "procedit autem sanguis velut à victimâ, et cito coagulatur, si sana fuerit mulier." Mauriceau† says that menstrual blood does not ordinarily differ in any way from that which remains in the woman's body. So also Haller and Hunter, both of whom regarded menstruation as a natural evacuation of blood.

The results of these careful investigations therefore warrant the conclusion that the menstrual fluid, at the moment of its effusion, consists of pure blood, mixed only with the small quantity of mucus and epithelium which it receives in passing through the body and neck of the uterus, and that at this point it always has an alkaline reaction. But that in the course of its passage through the vagina the original fluid becomes mixed with the mucus of that canal, which there exists in increased quantities, and that in the acid of that mucus the fibrinous portion is so far dissolved as to render the detection, by chemical means, of fibrine, as a constituent of the secretion, difficult or impossible. So much, however, of fibrine as belongs to the blood-corpuscles must always be present, for these bodies exist in

* Théorie Positive, Atlas, plate xii.

* Müller's Physiology by Baly, p. 1481.

† Traité des Mal. des Fem. Gross. p. 45. 3rd ed. 1681.

large quantities in every instance of a healthy menstrual flux.

Source of the menstrual fluid. — The vagina, the os and cervix, and the body of the uterus, have been severally regarded as the parts which furnish the menstrual flux. And so far as the mucous element is concerned it is probable that all these surfaces contribute a certain proportion; but that the blood in normal menstruation is derived mainly from the lining membrane of the body of the uterus, is placed almost beyond doubt by the following considerations: —

1. In the uterus of one who has died whilst menstruating, a remarkable difference is usually perceptible in the condition of the mucous membrane lining the cavity of the body and cervix respectively. That of the body is highly injected, of a deep red colour, the vessels distinct, and the capillaries numerous. That of the cervix exhibits a condition the opposite of this. It is pale, uninjected, and free from all appearance of distended vessels.

2. If such a uterus be injected, the same conditions are observed in a more marked degree. All the capillaries on the mucous membrane of the body are filled, but comparatively few of the cervix; an abrupt line of demarcation occurring sometimes at the internal os uteri.

3. If gentle pressure be employed, as by taking the uterus in the palm of the hand, and slightly approximating the two sides, blood is perceived to flow up from the little pores or orifices of the utricular glands, which are everywhere perceptible, upon the surface of the mucous membrane, until this collects in the cavity in a quantity sufficient to cover the surface.

4. If the same experiment be made under water, in a dish or shallow basin, with the aid of very gentle pressure on the sides of the uterus, such as could not apparently cause any rupture of uterine vessels, the little streamlets of blood are seen welling up from each pore, and mingling with the water. In neither of these cases is the blood seen to proceed from any part of the cervix, but only from the lining membrane of the uterine cavity.

5. The blood, in ordinary menstruation, is seen to flow from the os uteri into the speculum, but is never observed to proceed from the lips of the cervix, except the latter be in an abnormal state.*

6. The cavity of the uterus, after death during menstruation, has been frequently found to contain blood or a coagulum.

From these observations it may be concluded, that in normal menstruation the blood is furnished by the walls of the uterine cavity. Whether the lining membrane of the oviducts also contributes any portion of the fluid is not certainly known. But I have had reason to think this very probable, from observing that, in cases of death during menstruation, the tubes as well as the uterus contained blood, which may in some cases, however, have entered them by regurgitation from the latter. (See also p. 618.)

By what means does the blood escape from the uterine vessels in healthy menstruation? — The investigation of this question is attended by great difficulties, and data sufficient even for its approximate determination are yet wanting.

The explanations which have been offered are chiefly the following: —

(*a.*) The blood is supposed to escape in the form of a secretion.

So long as it was maintained that the menstrual fluid differed essentially from pure blood, the view that it was eliminated from the general circulating current by a process analogous to that which obtains in true secreting glands received ready acceptance, and the menstrual fluid was, in accordance with such views, denominated a secretion. But since it is now known with tolerable accuracy to what portion alone of the menstrual fluid the term secretion can, with any degree of truth, be applied, it seems useless further to argue the question of secretion or non-secretion, in reference to the main ingredient of this fluid, which has already been shown to be pure blood, unaltered in its physical and chemical constituents, until after it has become mixed with other and adventitious matters.

(*b.*) The blood is supposed to escape by transudation through the capillaries of the uterine mucous membrane.

This view, which is proposed by Coste* and others, need not be considered specially with reference to the uterus. Those who think that the blood-corpuscles, which microscopic examination proves to be abundantly present in the menstrual fluid, can pass by transudation, unaltered and entire, through the walls of capillary or other vessels without rupture of their coats, will find no difficulty in applying this explanation to the production of a like phenomenon, as it may be supposed to occur in the uterus.

(*c.*) The blood is supposed to escape through lacerated capillary vessels.

Many observed facts give to this view a certain amount of probability. Thus, in an injected uterus the capillary vessels, which form so fine a network upon its inner surface (*fig.* 439.), may be occasionally observed denuded, and hanging forth in detached loops. In such a condition I have found the vessels when death has occurred during menstruation.† Unless this is a post-mortem change, which is improbable, it may be assumed that this laying bare of the capillaries is the consequence of a vital action, whereby a portion of the epithelial and mucous surfaces are broken

* Whitehead, loc. cit. p. 24.

* Histoire du Développement, tom. prem., 1 fasc. p. 209. 1847.

† I am not prepared to assert that this condition is always present during menstruation, or that it is limited to such periods. A larger number of examples than those in which I have observed this feature would be necessary to establish such a fact; and the whole subject requires a closer examination than has yet been given to it.

down, and subsequently discharged, along with the menstrual fluid. According to the observations of Pouchet*, such an exfoliation of uterine epithelium takes place monthly in women and the mammalia generally. Pouchet, indeed, maintains that not only is there a monthly desquamation from the uterus, but that this extends to the separation and expulsion of a deciduous membrane on each occasion, and that this expulsion, which takes place in the form of the broken down elements of the deciduous lining of the uterus, constitutes the process described by him under the title of intermenstruation. Such an exfoliation, if it extended only to the epithelial cells surrounding the uterine capillaries, would simply leave them bare, but if proceeding to the extent of removing the whole deciduous uterine lining, would of necessity carry off with it the whole capillary network of vessels, (see *fig.* 539.) lying upon the face of this membrane, and consequently would leave a surface of torn capillaries, from which the hæmorrhage might occur †, and this in fact takes place in cases when dysmenorrhœal membranes are discharged (*fig.* 443.).

(*d.*) The blood is supposed to escape by permanent vascular orifices.

In the present state of our knowledge, the evidence in support of this view is not more conclusive than that upon which the preceding hypothesis is built: yet many circumstances lend colour to it. The question of a termination of the uterine vessels by open orifices has been occasionally, though obscurely, touched upon by different authors. Thus, Madame Boivin ‡, a most careful observer, after speaking of the "perspiratory orifices of extreme minuteness," visible upon the inner uterine surface, evidently meaning the orifices of the now well-known uterine glands, describes the manner in which the blood may be made, by pressure, to appear in droplets upon the inner surface of the uterus when death has occurred during menstruation; and, without giving a personal opinion, she elsewhere quotes the then prevailing views, that the blood is furnished by the exhalent extremities of arteries terminating upon the inner surface of the uterus. Dr. Sharpey § endeavoured, by various expedients, to determine what is the precise relation of the blood-vessels to these orifices in the decidua a little more advanced*, as, for example, in early pregnancy; but after expressing his conviction upon the subject, the precise anatomical connection between the two is left undetermined. Ordinarily, in injecting the uterus with fine coloured fluids, I have observed the cavity to become filled, the injection apparently escaping by the glandular orifices, which also themselves may be seen filled with injection. In some specimens a capillary branch may be observed passing to and stopping short at one of these canals or orifices, and having much the appearance of an open vessel. Without personally expressing an opinion upon this point until I have carried further some experiments now in progress, I may observe, that the idea of a permanently open termination of vessels here need not be set aside upon the objection that such an arrangement would produce a constant bleeding, because the vessels supplying the blood must first pass through a dense muscular tissue, amply sufficient to control or arrest bleeding, as indeed it does effectually after labour, when much larger mouths are laid open, and also occasionally when menstruation is suddenly arrested by powerful mental impressions, acting apparently upon the muscular fibre of the uterus; while many positive facts might be adduced in support of such a view, such as the frequent bleedings of uterine polypi, which are always invested by mucous membrane, the ready passage of fluids through the surface of the latter when their main vessels are injected, and the like.

What is the purpose of menstruation?—To this question no reply will be satisfactory which does not include the consideration of many other circumstances besides the mere escape of blood. Menstruation has evidently a much deeper signification than is declared simply by the flux, which is probably not the most important part of the function, although it constitutes the external sign or evidence of it.

Amid all the crude hypotheses of former times, such as that menstruation is due to fermentation, lunar influence, and the like, some of the older writers appear nevertheless to have had a dim perception of the truth when, under the form of an elegant type, they shadowed forth that which appears to be the real purpose of the menstrual act. The French term, "fleurs," and the English, "flowers," are now fallen into disuse; but they were employed in earlier times as designations of menstruation, for the purpose of suggesting that, after the example of trees, which do not bear unless the fruit is preceded by the blossom, so a woman does not become pregnant until she also has had her flowers.†

Menstruation is not established until the ovaries have reached a certain stage of development, and the maturation and discharge

* Théorie Positive, Huitième Loi.

† Pouchet, who does not enter upon the question of the effect which such a monthly denudation of the inner surface of the uterus would have upon its capillary vessels, nor, indeed, at all upon the consideration of the precise mode in which the menstrual fluid escapes, makes this supposed exfoliation and expulsion of the menstrual decidua occur at the periods intermediate between those of the menstrual flux. Thus the idea of a separative process, which might have been made comparable with that occurring in labour, when the entire ovum is thrown off and a bleeding surface is left, from which the lochial discharge takes place, loses its significance from the circumstance that this phenomenon is said to happen at periods when there is no bleeding.

‡ Mém. de l'Art des Accouch., quarto ed. p. 61. *et seq.*

§ Müller's Physiology by Baly, p. 1579.

* It must be observed that throughout this article the terms "decidua" and "mucous or lining membrane of the uterus" are employed as strictly synonymous.

† Mauriceau, Malad. des Femmes grosses. 1681.

of ova has commenced.* It continues to be performed as long as the process of ovulation is continued; but when the latter ceases, and the ovaries have become shrunken, their tissues attenuated and wasted, and Graafian follicles can be no longer distinguished, menstruation ceases to be performed.

These facts show that menstruation and ovulation proceed *pari passu;* but they do not alone prove that the one function is dependent upon the other.

If, however, both ovaries are congenitally deficient, no attempt at menstruation is ever observed; while, on the other hand, in cases where the ovaries are present but the uterus is deficient, puberty becomes established in due course, and then a regularly recurring menstrual molimen may be observed, although for the want of the uterus this function cannot be carried out. See note §.

Or if, under ordinary circumstances, after the regular establishment of menstruation, both ovaries become extensively diseased, or both are removed by operation†, menstruation is from that moment permanently suspended.

Hence it appears that the presence of the ovary in a healthy state is essential to menstruation.

But something more also is needed; for the ovaries may be present and healthy, yet if they cease for a time to mature or emit ova, as for example during pregnancy and lactation, when they are passive‡, then, so long as those processes endure, menstruation is also commonly suspended, but returns after the completion of one or both of them.

A series of facts so consistent appears to admit of but one interpretation: namely, that a menstruating condition of the uterus bears a direct relation to the active operations of the ovaries, and that this function is only performed under circumstances which render pregnancy possible so far as the ovaries are concerned; but if the conditions are such that impregnation cannot take place, then the uterus, although it may be healthy, does not menstruate.

But, in addition to this general relationship between menstruation and ovulation, it is necessary to determine further if any direct correspondence exists between each separate act of menstruation and the maturation or discharge of one or more ova from the ovary, so that these two acts shall be coincidentally performed.

The following evidence supports this view.

The ovaries at the menstrual periods are not unfrequently the seat of pain and tenderness, indicating some unusual activity of this part. This is most remarkable in the rare case of hernia of the ovary.§

In women who have died during a menstrual period the ovaries have been frequently observed to present unmistakable signs of the recent rupture of one or more Graafian follicles. Some examples of this fact have been already given. In one case the ovum itself was found in the Fallopian tube (p. 567.).*

Conception is supposed to take place most frequently within a few days after a menstrual period, and therefore during the time which an ovum, if it were emitted from the ovary during menstruation, would occupy in passing down the Fallopian tube and perhaps in arriving at the uterus.

Menstruation corresponds in many particulars with the œstrus, or rut, in the mammalia, and in them it is only during the œstrus that ova are emitted from the ovaries, and that conception can take place.

The foregoing facts constitute evidence bearing upon two distinct points. The first series proving that a menstruating condition of the uterus is maintained only so long as the ovaries continue in the active performance of their function of preparing and ripening ova. The second series affording a certain amount of presumptive evidence, that each separate act of menstruation is connected with or is dependent upon a corresponding act of maturation, and perhaps of spontaneous emission of one or more ova from the ovaries.

The accuracy of the first conclusion will probably not be questioned; but if the second point is to be regarded, as at present, more than an hypothesis having many facts and probabilities for its support; if, as M. Pouchet believes, we are justified in considering as established laws of generation that in man ova are emitted from the ovary at fixed epochs and at no other times, and that these occa-

* The views of Dr. Ritchie in dissent from this statement have been already noticed, p 572.

† See Mr. Pott's case, p. 573.

‡ Négrier's, loc. cit.

§ In a case of this kind recorded by Dr. Oldham (Proceedings of the Roy. Soc. vol. viii. p. 377.), both ovaries had descended through the inguinal canals, and were permanently lodged in the upper part of the external labia. At intervals of about three weeks one or both ovaries were observed to become painful and tumid, the swelling augmented for four days, remained stationary for three days, and then gradually declined; the whole process occupying generally from ten to twelve days. It happened, unfortunately, that in this case the uterus and vagina were deficient, so that menstruation could not take place; but the case in one respect is the more interesting on that account, for notwithstanding the absence of the uterus, all the external signs of puberty were present, and the evidence of a periodical activity and excitement of the ovaries, and of a menstrual molimen affecting the organs which were not malformed, were here unmistakable. These circumstances forcibly call to mind the painful condition of the ovaries which, in a similar case, induced Mr. Pott to extirpate those organs.

* Upon the connection between the discharge of ova from the ovaries, and the phenomena of heat and menstruation, the following should be consulted, viz.:—*E. Home*, Lectures on Comparative Anatomy, vol. iv., and Phil. Trans. 1817 and 1819; *Power*, Essays on the Female Economy, 1821; *R. Lee*, Cyclopædia of Practical Medicine, art. Ovary, 1834; *Gendrin*, Traité Philosophique de Médecine Pratique, t. i. 1839; *W. Jones*, Practical Observations on Diseases of Women, 1839; *Paterson*, Edinb. Med. and Surg. Journ. vol. liii; *Girdwood*, Lancet, 1842–43; in addition to the works of *Bischoff*, *Raciborski*, *Négrier*, *Coste*, and *Pouchet*, already quoted under the title Ovary, p. 568., where will be found a full account of the process of ovulation.

sions, which furnish the sole opportunities for impregnation, bear the same constant relation to menstruation that the acts of ovulation and the times of conception in the mammalia bear to the œstrus, it becomes necessary to examine more closely the grounds of this belief; and for this purpose the circumstances as yet ascertained regarding the times of conception in women, the condition of their ovaries, not only during menstruation but in the intervals also, and the actual relation which the œstrus, or period of conception in mammals, bears to menstruation, may be briefly passed in review.

The precise period at which conception in the human subject occurs in most cases cannot, for obvious reasons, be determined, but whenever conception can be traced to a single opportunity, the process of impregnation, or the fertilisation of the ovum by contact with the spermatozoa, may be assumed to take place within a few hours after the act of insemination; for the spermatic fluid rapidly traverses the generative canal, while here spermatozoa cease to have motion within thirty hours at latest from the time of emission.

From various methods of computation it is supposed that in a large majority of cases conception occurs during the first half of a menstrual interval, and most commonly during the first week. In sixteen instances noted by Raciborski conception occurred as late as the tenth day after menstruation in only one case.*

The number of instances in which conception can be ascertained, or may be fairly assumed, to have taken place in the latter half of a menstrual interval is comparatively small. Nevertheless impregnation may unquestionably occur during this time, and even within a day or two of the next menstrual flow, which is then usually diminished in duration and quantity, or is reduced to a mere show.

Now if we endeavour to explain these facts, relating to the times of conception, by the aid of an ovular theory of menstruation, the question may be brought within very narrow limits. One of two postulates may be assumed. An ovum emitted at or soon after a menstrual period either remains susceptible of impregnation through the whole of the succeeding interval, or it loses that susceptibility, and perhaps perishes before the recurrence of the next menstrual flow.

The first hypothesis would sufficiently account for impregnation taking place at any part of a menstrual interval; but it has little or no evidence for its support. Nothing, indeed, is known regarding the length of time during which the human ovum remains susceptible of impregnation after it has escaped from the ovary. The period of susceptibility in the mammalia generally is variable. In the bitch, as already stated (p. 606.), the ovum, after quitting the ovary, is supposed to remain in the tube during six or eight days. Its passage is probably quite completed in ten days. In the guinea-pig the period is much shorter, as the ovum enters the uterus at the end of the third day. In the rabbit also the period does not extend beyond the beginning of the fourth day. But by the time that the ovum reaches the uterus, or sometimes even the lower end of the oviduct, in most of the mammalia yet observed, the œstrus is past, and with it also the opportunity for impregnation. The evidence therefore obtainable from the mammalia fails to support the conjecture, that in man an ovum detached during menstruation can remain susceptible of impregnation through the whole of a menstrual interval, consisting of twenty-three or more days, although the period of this susceptibility *may* be longer in man than in the other examples cited.

But if this first hypothesis fails, the second appears inevitable, viz., that an ovum emitted during menstruation loses its susceptibility of impregnation before the termination of the succeeding menstrual interval. M. Pouchet supposes, that in the human subject the duration of this susceptibility does not exceed fourteen days. Consequently if, according to the strict formula of the latter physiologist, ova are emitted only at or shortly after the menstrual periods, there must remain a portion of each menstrual interval, during which every woman is physically incapable of conception. And this alternative M. Pouchet* does not hesitate to adopt.

But since this conclusion is incompatible with the facts already stated regarding the occasional, though probably rare occurrence of conception during the latter portion of a menstrual interval, and especially towards its conclusion, M. Coste, who shares with many others a belief in these facts, has proposed an explanation which constitutes a very considerable modification of the ovular theory of menstruation. To account for impregnation at a later period than usual of a menstrual interval, M. Coste supposes that a ripe or distended Graafian follicle, having failed in reaching the point of rupture, may remain stationary, as it sometimes does in mammals †, and that the influence of the male is sufficient to determine the dehiscence of a follicle in such a state. And in order to anticipate the obvious objection, that if the emission of an ovum from the ovary is the cause or occasion of menstrua-

* These and similar facts have been commonly regarded as showing a greater *aptitude* for conception shortly after menstruation; but the influence of mere *opportunity* has not perhaps been sufficiently considered; for if, as in the case of the Jews under the strict requirements of the Levitical law, the whole of the first week, or that period which is commonly regarded as most favourable to conception, be withdrawn from the opportunities for impregnation, no diminution whatever of prolific power results.

* Théorie Positive. — M. Pouchet believes that a slender decidua is always formed at the decline of each menstruation, which, together with the ovum, whenever the latter is not impregnated, is cast off from the uterus between the tenth and fourteenth day, and that after this event every woman remains incapable of conception until the next menstrual period, when the detachment of another ovum from the ovary renews her capacity for impregnation.

† For a fuller statement of this view, with illustrative examples, see p. 568.

tion, the latter phenomenon ought to be repeated whenever the former event occurs; and consequently in the case now under consideration M. Coste suggests that the same cause which provokes the discharge of the ovum in this case, also occasions fecundation, which arrests the menstrual flux before this has time to manifest itself.

Thus, if even the foregoing explanation could be deemed satisfactory, it appears necessary occasionally to fall back upon the old doctrine of the detachment of ova coincidently with fecundation, in order to supply the deficiencies of the newer theory of their spontaneous emission independently of it. It must however be confessed, that every view yet offered of the direct dependence of each separate act of menstruation upon a corresponding act of ovulation, disappoints expectation by leaving some condition relating to conception unexplained, or explainable only by raising an additional hypothesis; while many circumstances of common occurrence, such as the sudden reappearance of menstruation under mental emotion and the like, are left unaccounted for upon any hypothesis of ovarian dominance.

If next the ovular view of menstruation be tested by the evidence derived from anatomy, although many facts will be found in proof of the statement that ova are often emitted at the menstrual period, these cases have not been yet sufficiently collated to form a series capable of affording unquestionable conclusions as to the precise relation which the emission of ova bears to each menstrual act. That ova may pass spontaneously from the ovary during the menstrual flow is proved by cases already given at p. 567. and 605. M. Pouchet, however, supposes that it is the *maturation* of the ova which takes place during menstruation, and that their *emission* follows immediately or within four days after the cessation of the flow. M. Coste found the period of *rupture* of the Graafian follicle to be very variable. In one case the follicle was already burst on the *first* day of menstruation. In a second instance, although *five* days had passed from the cessation of the flux, the follicle was still entire, though the slightest pressure sufficed to cause its rupture. In a third case *fifteen* days had elapsed, and yet rupture had not taken place. In the example represented by fig. 380. *ten* days had passed since the last menstruation began, and the follicle was entire, though perfectly ripe, and apparently upon the point of rupture.

These examples, in the same degree that they favour a belief in the occurrence of impregnation at indefinite periods of the menstrual intervals, by showing how conception is then possible, discourage the view that the *emission* of ova is necessarily limited to the precise times of the menstrual flow. But until a larger number of examples than yet exists, showing the condition of the follicles during both the menstrual periods and intervals, has been collected and carefully compared, no definite conclusions as to the exact relation which the *emission* of ova bears to each act of menstruation can be arrived at, so far as anatomical evidence is concerned. For the attention of observers having been directed more to the condition of the ovaries at the time of menstruation than in the interval, much more has been ascertained of their state at the former than at the latter periods. Yet it is during the intervals of menstruation that conception in man normally takes place, while mammals become impregnated only during the œstrus.

It is important, therefore, to determine, thirdly, how far the œstrus or rut in the mammalia may be regarded as comparable with the act of menstruation in the human female; for if, as is commonly supposed, these two functions are identical, or nearly so, then the facts to be derived from comparative anatomy may assist further in determining the nature and extent of the relation between menstruation and ovulation in man. But if the phenomena attendant upon the rut do not, in all respects, coincide with those accompanying menstruation, the conclusions which are legitimately deducible from observation of the former function must not be too strictly applied to the latter.

In the mammalia the periods of emission of the ova from the ovary, and of their passage down the Fallopian tube, are undoubtedly coincident with the œstrus. It is only on these occasions that the female manifests an instinctive desire for copulation. She is then said to be in heat. The vulva is congested, swollen, and bedewed with an increased secretion, which is generally odorous, and is sometimes tinged with blood. This condition is of brief duration. At the longest it continues for a few days. But whatever be its duration it is the only period during which the female can be impregnated.

In the human subject the periodical return of congestion of the reproductive organs, the menstrual flow, and the corresponding spontaneous emission of ova, so far as this point has yet been ascertained by post-mortem examination, accord with the phenomena displayed by the mammalia during the œstrus. It is also believed that in some instances conception has taken place *during* menstruation*, a circumstance which is clearly reconcilable with the anatomical evidences already produced, and is so far in accordance with what normally occurs in the mammalia during œstruation.

But here the analogy ceases. And from this point onwards the more closely the two functions are compared, the more plainly does it appear that although the œstrus and menstruation possess many circumstances in common, yet the resemblance endures only for a certain period, more or less brief, while, after this is past, there follows in man an intermediate condition which is not only not comparable with the corresponding intermediate

* Some of the few authorities for this fact extant are quoted in the works of Pouchet and Coste, *loc. cit.*

state in animals, but is in many of its essential features the direct converse of this.

For, as already stated, in the mammalia usually by the time that the ovum has reached the uterine extremity of the oviduct, or has entered the uterus, the opportunity for impregnation is lost, the œstrus is over, and the animal refuses the male: all the conditions immediately necessary to procreation then pass away, and an interval of perfect inaptitude ensues, which is sometimes so remarkable that not only are no ripe ova to be found in the ovaries, but even the male organ ceases to secrete semen. In this series of recurrent periods, marked by irresistible impulse, alternating with total inappetence for congress, nothing is more evident than that each corresponds with an internal physical condition, of which it affords a most intelligible explanation. The appetency occurring and remaining only as long as congress would be fruitful; the inappetency returning whenever this would be necessarily infertile.

Now, with regard to the human subject, whatever may be *possible* during menstruation, yet essentially the intervals of the menstrual acts are the times of fertility in women. And the only question that can arise upon this point is, whether the power of conception extends over the whole or over a part only of this interval—a question that has been already considered.

In all that relates, therefore, to the coincidence of the ovipont with the œstrus of mammals, the evidence derived from comparative anatomy serves to strengthen the belief in a corresponding correlation between the emission of ova and the act of menstruation in the human subject. But in respect of the interval, the great divergence of the facts here displayed tends to embarrass and perplex rather than to elucidate the question as it relates to man. For it is precisely in this interval that all the circumstances occur which, for want of a consistent explanation, have often thrown a doubt over the whole theory of the direct dependence of menstruation upon ovarian influence; and in elucidating these points, comparative anatomy affords little or no help.

In taking a retrospect of these several facts relating to menstruation and its connection with a corresponding ovipont, an essential distinction should be made between the influence of the ovaries in determining the power of the uterus to perform the menstrual act, and any influence which they may have over the periodicity of that function. In all that relates to the former faculty, the power of the ovaries may be regarded as indisputably established. In much that is connected with the latter, there is obviously room for more information than we at present possess.

If each separate act of menstruation is determined by certain modifications periodically occurring in the ovary, it is probable that the essential part of the process is the *maturation* of an ovum within the follicle, while the process of its *emission* may be an accidental feature, not always occurring, sometimes happening spontaneously, and sometimes caused in the way already suggested, but having nothing necessarily to do with the menstrual act, although the time of its occurrence may materially affect the period of a resulting impregnation.

The purpose of the *flux* remains to be considered. If the quantity of fluid escaping at each recurrence of menstruation be estimated at three, or possibly five, ounces, and the process is repeated, without interruption from pregnancy, lactation, or disease, once in every lunar month, or thirteen times annually for thirty years, then an aggregate quantity of seventy-two pounds or nine gallons on the former supposition, or of a hundred and twenty-two pounds or fifteen gallons upon the latter estimate, will have passed from the system in the course of menstrual life, and, so far as this is composed of blood, will have been apparently entirely wasted.

It is difficult to arrive at a perfectly satisfactory conclusion regarding the purpose of this large loss. For the external escape of blood must be regarded as, to a certain extent, an accidental feature in the process of menstruation. That it is not essential to fertility, is proved by the fact that women sometimes, though very rarely, breed who do not menstruate; that the temporary suspension of the menstrual flow during lactation is no certain preventive of conception; and that, occasionally, young girls become pregnant before the menstrual age has arrived.

The blood which escapes is certainly converted to no positive use. No office can be assigned to it, such, for example, as has been suggested for the analogous escape of blood into the ripe ovisac — an effusion that has been termed the menstruation of the follicle.* But although the blood, after it has passed the uterine epithelium, is altogether lost, it may, by escaping, fulfil the negative purpose of affording relief to the congested capillaries of the uterus. For we find, from various kinds of evidence, that, at each menstrual period, all the uterine tissues become charged with a more than ordinary quantity of blood, and, therefore, with the materials necessary to those rapid growths which have been shown to commence as soon as impregnation has taken place. From the moment that the latter occurs, the mucous and other tissues of the uterus begin rapidly to expand, and the current of blood is diverted to new channels. There is then no overplus, until the whole cycle of generative acts, including lactation, is complete. The only observable break happens at parturition; but after the balance of the uterine circulation has been restored by the escape of blood at the time of labour, and by the lochia, there is again usually no redundance until the office of the mammary glands has ceased. Then, the activity of the ovaries recommencing, the periodical hyperæmia of the uterine vessels returns, and the overplus is emitted in the form of menstrual

* See p. 556.

blood. And thus, by each act of menstruation, the uterus is placed in a state of preparation for that profuse development of its tissues which impregnation may at any time of the succeeding interval call forth.

The office of the uterus in insemination.— After menstruation, which is to be regarded as a process preparatory to impregnation, the next office of the uterus is that of receiving the seminal fluid, and apparently of conducting it to the Fallopian tubes, by which again it may, in rare instances, be carried as far as the ovary. To this office the form of the uterus appears to be well adapted in all its parts. For, first, the cervix uteri is so constructed as to lie in the centre of the upper dilated portion or fornix of the vagina, into which it projects to a distance of 3—4‴. This dilated extremity of the vagina forms a pouch which receives the extremity of the intromittent organ, and in this receptacle the seminal fluid is deposited. But, on account of the natural position of the uterus, which lies in the axis of the pelvic brim, while the course of the vagina corresponds with that of the cavity and outlet (*fig.* 433.), the cervix uteri is so directed (downwards and backwards) as to cause the os uteri externum to be maintained in the very centre of this pouch, so that the seminal fluid will be retained in a situation in which it is most certain to flow through this orifice into the cervix.* But the cervical canal is traversed by numerous furrows, which will act as so many channels, conducting the semen to the internal os, while the dilated central portion of that canal (*fig.* 424.) serves the purpose of a second reservoir.

It may also be readily believed that the ejaculatory act on the part of the male will suffice to carry the seminal fluid thus far, although the impetus with which it is propelled having been checked by the constriction caused by the external os uteri, would hardly suffice to carry it much beyond the more narrow barrier existing at the internal os. Or if it should pass this second obstacle, the almost complete apposition of the walls of the uterus would prevent any considerable penetration of the semen further into the uterine cavity, so far as this is dependent on the act of ejaculation.

But this very apposition of the uterine walls may, in another manner, assist the onward progress of the semen, by inducing a kind of capillary attraction, such, for example, as will cause water to rise, to a certain distance, between two plates of glass placed in close contact. The rigid walls of the human uterus, which are normally in such close apposition that sections made in certain directions scarcely suffice to display any appreciable cavity (*figs.* 426. and 427.), seem admirably adapted to favour this gradual rise of the seminal fluid between them towards the Fallopian tubes; and thus a compensation is provided for that peristaltic movement, which, in some mammalia with a more intestiniform and less rigid uterus, appears, under the influence of the coitus, to affect alike the vagina, uterus, and Fallopian tubes*, and to suffice for the conveyance of the seminal fluid from one extremity to the other of the generative track.

The action of the cilia of the uterine epithelium cannot, in any way, contribute to this result, if those observations are correct which agree in assigning to them a movement such as would create a current from within outwards; for it is obvious that such a motion would tend to retard rather than to advance the progress of the seminal fluid towards the Fallopian tubes.

If therefore any other power is needed to account for this movement, it must be sought in the action of the spermatic particles themselves. For, little adapted as their motions appear to anything like onward progression, yet they have been observed to continue long after ejaculation, in the fluid found within the uterus and tubes, and even upon the ovary.† It has been also proved beyond doubt that by this power the spermatozoa penetrate the ovum itself‡, and therefore to it may be attributed a certain share in the progress of the seminal particles through the uterus towards the oviducts, although this may not be a very considerable one.

Finally, it is possible that in man and the mammalia some such remarkable property may be possessed by the spermatozoa as that which I have observed in certain annellides. If a portion of the contents of the testis of the common earth-worm (*Lumbricus agricola*, Hoffm.) be placed under the microscope between two slips of glass, in about ten minutes the whole mass is seen to heave and writhe with astonishing energy, the form of the movement being that of the peristaltic action of the intestines (*fig.* 459.). Everything in contact with the spermatozoa becomes ciliated by them, one end of the filament fixing itself while the other vibrates free. The result is, that if the body to which the spermatozoa attach themselves is fixed, such as the glass, or the margin of a mass of granules, a line of cilia is formed whose action creates a strong current, and everything movable is drawn into the vortex, and is seen drifting rapidly along. But if the body to which they attach themselves is movable, then this soon becomes clothed with spermatozoa,

* Dr. James Blundell has described a peculiar movement which he observed in the vagina of the rabbit, and which serves to explain the mode of introduction of the seminal fluid into the uterus:— "This canal during the heat is never at rest; it shortens, it lengthens, it changes continually in its circular dimensions; and when irritated especially will sometimes contract to one-third of its quiescent diameter. In addition to this action the vagina performs another," which "consists in the falling down, as it were, of that part of the vagina which lies in the vicinity of the wombs; so that it every now and then lays itself as flatly over their orifices as we should apply the hand over the mouth in an endeavour to stop it. How well adapted the whole of this curious movement is for the introduction of the semen at the opening it is needless to explain." —Researches Phys. and Pathol. p. 55. 1825.

* Blundell *loc. cit.*; see also p. 611. of this article.

† See this article, p. 607.

‡ Newport, Phil. Trans. 1853. Pt. II. p. 267.

whose free ends moving rapidly, cause the whole to rotate. A most remarkable object

Fig. 459.

Spermatozoa of Lumbricus agricola in motion and forming cilia. (*Ad Nat.*)

is thus formed, which continues for a considerable time in motion, clearing for itself a free area, and in this it revolves, whilst its revolutions are apparently assisted by the action of other spermatozoa, which, having attached themselves to the periphery of the cleared space, keep up a perpetual vortex, in which the central body is partly a passive and partly an active agent.*

Whether any similar effect is capable of being produced by the spermatozoa in the human subject, or how far this property may be general in spermatozoa, I am not aware; but the circumstance is altogether too remarkable to be passed over without mention here, as it may serve to explain how the onward movement of spermatozoa can, in some cases at least, be aided by this peculiar property of the spermatic filaments to attach themselves to surfaces with which they were in contact, and to clothe these surfaces with a fringe of cilia capable of producing the ordinary effects of cilia in motion.

The office of the uterus in gestation.—The process of gestation may be considered to commence from the moment that the ovum, which has been subjected to the fertilising influence of the male generative element in the Fallopian tube†, is received impregnated into the uterine cavity. If no such contact of the generative elements as is necessary to the development of the ovum takes place, then the latter suffers no further change beyond that slight alteration in its condition during its passage through the oviduct, which has been already described; and ultimately it becomes lost, probably suffering decomposition, but at least giving no evidence of its presence in the uterine cavity. But if the ovum has been fertilised, then commences that remarkable series of changes in the physical condition of the uterus whereby this organ is fitted for the protection and nutrition of the ovum during the usual period of forty weeks in which the latter is normally retained within its cavity. As these changes involve very considerable alterations in the form and composition of the entire uterus, as well as of its several parts, they have been considered as a part of that series of metamorphoses which the uterus undergoes in its progress from infancy to old age, of which a description has been already given, (p. 644.).

The office of the uterus in parturition.—The act of parturition, or that process by which, in normal cases, the product of conception, after due development, is spontaneously separated and expelled from the parent body, constitutes the last chief office of the uterus.

The labour process may be regarded as essentially a contest between two opposing forces, which are *resisting* on the one hand, and *propulsive* on the other. Resistance is necessary to preserve the fœtus in its place. Propulsion is requisite to detach and expel it from the parent body. The resisting force is chiefly passive in its operation. It is that which is offered by the membranes enclosing the fœtus, by the os and cervix uteri, by the soft parts lining and closing in the pelvis, and lastly by the osseous and ligamentous structures of the pelvis itself. Naturally, these are sufficient to counteract any tendency to the escape of the fœtus from the operation of gravity upon it, in various changes of posture, or under any impulsive movements of the parent body. Their combined resistance is such as to require the operation of powerful muscles to overcome them before the child can be expelled. This power is supplied by the uterus, aided subsequently by the diaphragm and other muscles, abdominal and pelvic. Labour constitutes the performance, and birth the end of the process, for the accomplishment of which in a natural manner the forces should be nearly evenly balanced. The preponderance of power being, however, at first, on the side of resistance, and finally on that of propulsion. Whenever the forces are thus proportioned, the act of parturition is, *cæteris paribus*, natural. Whenever they are greatly disproportioned, the process is abnormal; whether the error be on the side of too much resistance, or too little propulsive force. In these last two particulars may be comprehended the history of every unnatural labour in which the mechanism* is at fault.

* These observations were first made by me at the time when the late Dr. Martin Barry announced his discovery of the penetration of the ovum by the spermatozoa in the rabbit, and were communicated to him, and subsequently for publication to Prof. Owen, in whose lectures on the invertebrata this account appears. Lectures on the Comp. Anat. and Phys. of the Invertebrate Animals, by Richard Owen, F.R.S., 2nd edit. p. 257.

† See p. 609.

* The mechanical operation of the parts concerned in labour having been reserved for con-

When labour is about to commence, the uterus having previously taken a lower position in the pelvis, begins to contract gently, and often without pain, so that the only or chief evidence of its action is an occasionally recurring tension and hardness of the organ.

These contractions commence apparently at the cervix, so far as it is possible to analyse them, and travel onwards towards the fundus *: the whole organ soon becoming firm and resisting to the touch, and its upper part rising and assuming a more prominent position in the abdomen. This hardness and tension is occasioned partly by the rigidity of the whole fibre, in a state of tonic contraction, and partly by the resistance offered by the incompressible contents of the organ, for which there is no exit so long as the cervix remains closed.

The contraction having overspread the uterus, a sense of pain is now first felt; the pain, like that of cramp, being usually proportionate to the sensible tension and hardness of the organ.

After enduring for a time the state of contraction gradually subsides, and is replaced by one of relaxation. In subsiding, the contraction observes the same order as in commencing, the os and cervix yielding first, while the upper portion and fundus remain longest tense and hard. From this it results that the antagonistic force, exerted by the two extremities of the organ, not being throughout contemporaneously and equally employed, the excess of the fundal over the ostial contraction will represent the measure of the unopposed, and consequently efficient, propelling power.

The period of action is followed by one of repose, in which the organ remains relaxed, and no pain is experienced.

After an interval of variable duration contraction returns, and continues to recur in rythmical order, but with a gradually diminishing interval, while at the same time the contractions, especially at the fundus, increase in intensity and duration.

As a result of these successive contractions, the os and cervix slowly yield, and a portion of the fœtal membranes, containing some liquor amnii, protrudes, in the form of a pouch. This, as the os uteri becomes still further opened, is followed by the head or some other portion of the child, which, having entered the vagina, ultimately fills up the pelvis, and distends the perineum.

At this period the abdominal and pelvic muscles are brought powerfully into play. Their cooperative action is occasioned by the parts of the child occupying the pelvis irritating structures which are abundantly supplied by spinal nerves. And now the chief use of spinal reflex action, in relation to labour, becomes manifest, not so much in regard to the uterus itself, whose contractions are probably still mainly dependent upon its own sympathetic nerves, as in that correlation with other parts, between which and the uterus it is essential that consentaneous action should be occasionally established.

The powerful cooperation of the abdominal muscles, which form as it were an additional sheet of contractile fibre, nearly surrounding the uterus, being thus enlisted, the passage of the child is completed with greater rapidity and certainty; and, after a pause, the placenta and membranes are expelled, the liquor amnii having, either altogether or in part, escaped at some earlier period of the labour.

This general sketch of the operations of the uterus in labour will suffice as an introduction to a more detailed and critical examination of the nature of the forces employed, and of the manner in which these are called forth.

Of the peristaltic action of the uterus, and its cause. — From direct observation upon many mammalia, it is known that the action of the uterus is in them peristaltic, *i.e.*, the contractions commence at certain points, and pass on from segment to segment slowly, and in a vermicular manner. If a single point of an organ so composed is irritated, the action starts from the point of irritation, and spreads outwardly, and by irritating different points, other peristaltic centres may be obtained.

Although the human uterus does not admit of the same direct methods of observation which can be employed in animals, yet from all that is known, we may conclude that its mode of contraction does not differ in any important particular from that of other similarly constructed hollow muscles, when engaged in propelling or expelling their contents.

The principal circumstances bearing upon this point in regard to the human uterus are the gradual and slow contraction, followed by an equally slow return to a state of relaxation —phenomena easily observed, when the hand is placed upon the abdomen of a woman in labour—a certain tremulous motion of the os uteri, when contraction is commencing, followed by a sensible gradual hardening of the uterus, before the woman is herself conscious of pain; the longer abiding of the contraction at the fundus than at the cervix; and the occasional segmental contraction of the organ after labour, commonly termed *hour-glass contraction* *, which may occur at any point intermediate between the fundus and cervix, and which resembles similar contractions of common occurrence in other hollow muscles, whose action is peristaltic. These several circumstances, added to the general analogies, suffice to show that the action of the human uterus is peristaltic.

Peristaltic action, as it occurs in vertebrate animals, is found to depend upon the structure of the organ displaying it, rather than

sideration in a separate article (PARTURITION, MECHANISM OF, Vol. III. of this Cyclopædia), the vital endowments only of the uterus, as far as these relate to the parturient act, are here examined.

* Wigand, Die Geburt des Menschen. Berl. 1820. *Supp.*

* See p. 702.

upon the mode of its innervation or excitement. So that if in a situation where organic fibre is usually found, the intestine, for example, of *cyprinus*, the part is composed of striated muscle, then no organic or peristaltic action can be produced in it; but upon excitement, contractions of the kind usually seen in striated muscular fibre ensue.*

In the same way the peristaltic action of the uterus, although exhibiting certain differences, according to the manner in which it is evoked, is nevertheless to be referred to the peculiar composition of unstriated fibre, and not to the mode of innervation or excitement of the organ.

For the muscular fibre of the uterus is not bound up in separate sheaths, as voluntary muscles are, nor do the fibres run principally in one direction, nor are they long and continuous — conditions all favourable to that quick transmission of nerve influence, and rapid action which occur in voluntary muscle — but the fibre cells are for the most part distinct, lying in apposition, or imbedded in a matrix of amorphous tissue (*fig.* 436.), and forming by their combination intricate laminæ.

Through a tissue so composed, the influence of a stimulus can only be propagated slowly, and the organ formed of it can only contract after a vermicular or peristaltic manner. Nevertheless, the power, the endurance, and the orderliness of the action that ensues, will be, to a certain extent, dependent upon the nature and mode of application of the excitant. It cannot be questioned that, under many circumstances, the direct application of a stimulus to the uterine muscular structure excites its contractions in the same manner that the food does those of the œsophagus and intestines, without any intervention whatever of nerve. This happens when the hand is passed into the bare uterine cavity after labour, or when the membranes are separated from the inner surface of the uterus by a catheter.

To bring such an organ into *co-ordinated* action, all that appears necessary is, that nerve fibres should enter its tissue at a certain number of distinct points or centres, whence the irritation excited at these spots being propagated from fibre to fibre, may spread through the mass, until the whole is brought into harmonious operation.

And it need not excite surprise if these centres of excitement are few, and the nerves of the gravid uterus consequently not numerous; for a more abundant supply of nerve force, and more rapidly recurring contractions, would be prejudicial in labour, by bringing the uterine walls more constantly and violently into contact with the fœtus, and by driving out the blood passing through them so rapidly as to cause dangerous regurgitation, or so frequently as to produce fœtal asphyxia, through too constant interruption of the placental circulation.

* Weber, in the article *Muskelbewegung*, in Wagner's Handwörterbuch. 1856.

It is in favour of the views of Wigand, who maintains that uterine action begins at the cervix, and travels upwards, that the cervix receives a larger supply of nerves than the fundus, so that the action may be here first established, and the fundus afterwards excited. But however this may be, it is known that unless all parts of the organ are eventually brought into consent, the labour does not proceed regularly, for if one portion is felt to be hard, and another at the same time soft, irregular action and spurious pains ensue. To ensure, therefore, consentaneous action between the respective points of the uterine fibre at which the nerves enter its tissue, and to establish and regulate the movements, appear to be the offices of the nerves in relation to the uterine structure.

Of the rythmic action of the uterus, and its cause. — The uterus, like the heart and the respiratory muscles, is time-regulated or rythmic in its action. In this action the usual three rythmic periods are noticeable, viz., a period of contraction, a period of relaxation, and one of repose.

The sensible phenomena which accompany the first period are, a gradually increasing and sustained hardness of the uterus, a gradual approach and continuance of suffering, and, after a time, a certain advance of the presenting part of the child. These occurrences do not commence coincidently, but each overtakes the other in the order enumerated.

The phenomena of the second period are, the gradual subsidence of the hardness, the gradual passing away of the pain, and the retiring of the presenting part, and these are more nearly coincident than the former.

The third period is marked by an absence of all sensible signs.

These three periods together constitute the uterine rythm, which observes certain laws, that are in some respects different from those which govern the rythmic action of other parts, as for example, of the circulatory and respiratory organs respectively.

In the action of the uterus, the repeats take place more slowly than in either of the instances just named, although between these two, also, there is a proportionate difference, nearly, or quite as great. The heart's rhythm being quickest, the respiratory rythm slower, and that of the uterus slowest of all.

But the rythm of the uterus does not observe a constant or uniform rate. At the commencement of labour, the order of sequence of the rythmic motion remains for a time tolerably constant; but as the process advances the rythm becomes modified, so that, like the example of the heart under violent emotion, the interval shortens, while the force and vigour of the contractions increase.

It is a matter of great interest to discover, if possible, the determining cause of this rythm; that which constitutes the regulating as well as the disturbing force. The latter should be rather termed the accelerating

force, for it is beyond question a healthy necessity which, for the purpose of advancing the process, demands this graduated change of the uterine rythm throughout labour. Rythm plainly does not, like peristaltic action, depend upon the structure of the organ which displays it, for the three examples here taken, viz., respiratory muscles, heart, and uterus, differ from each other materially in composition. The first consists of striated voluntary fibre; the second of striated involuntary fibre; the third of unstriated involuntary fibre. It may therefore be concluded, that something else than structure determines rythm. This appears to depend rather upon the manner in which the contractions are evoked, and hence upon the mode of innervation, which is different for each organ. The heart and respiratory muscles each admit of more easy observation than the uterus, and referring to them for aid in the elucidation of this question, we find that each of these organs, or sets of organs, is provided with a nervous rythmic centre, upon which its rythm depends, and upon the injury or destruction of which the rythm immediately ceases, — the rythmic centre of respiration being in the medulla oblongata, and that of the heart in its own proper ganglia. Which of these divisions of the nervous system furnishes the rythmic centres of the uterus has not been determined, but from the analogies just quoted, we may select by preference the heart, because its actions most nearly resemble those of the uterus, in being purely involuntary, while the case of the respiratory muscles constitutes an example of mixed movements wherein volitional can be superadded to unconscious rythmic motion.

If therefore the rythmic action of the uterus is regulated in like manner with that of the heart, we must, upon the strength of this analogy, look for its rythmic centres among the sympathetic ganglia which lie nearest to the organ.

And this view does not necessarily exclude a certain influence of the spinal nerves over the rythmic action of the uterus. For just as under emotion or bodily excitement both the cardiac and respiratory rythms are accelerated, so, as labour advances, and more parts become irritated, the uterus appears to receive an addition of nerve force which may be possibly acquired from other and more distant centres than its own proper ganglia.

The heart's rythmic centres have been regarded by some physiologists as so many "magazines" of nerve-force, whence at regulated intervals this force is discharged, causing the muscular structure to contract in accordance with the rate of supply of the stimulus. The influence of these nerve-centres is best shown by placing a ligature upon them, or by cutting them away. When hindered in their operation by tying, the *rythm* ceases, though the motor power is not lost. When they are cut away, together with certain portions of the heart, the other portions cease to have rythmic motion, though they may still be artificially excited to repeated single actions.*

But an inconstant stimulus thus furnished to the muscular structure being powerless to produce a permanent or tonic contraction, the effect after a short time passes away to be reproduced upon a fresh application of the excitement. In this way rythm, so far as it is dependent upon nervous supply, is apparently determined.

But in the case of the uterus we observe that the *rate* of the rythm must be to a certain extent limited by the peculiar nature of the uterine fibre. For this, as already shown, is of a kind which cannot be excited to *rapidly repeated action* like the heart. In this form of fibre the response to the stimulus is slow, and often does not take place until after the excitant is withdrawn. Hence the meaning of that slow repetition of uterine action which is observed in ordinary labour.

When this point is further examined, it will be found that, according to the degree or kind of excitement employed, the uterine rythm may be merely accelerated, or a rythmic may be converted into a more continuous action. The influence of the passage of the child during labour over successive surfaces in quickening uterine action has been already shown. Another example may be drawn from the effects of ergot. When ergot is given by the stomach some time usually elapses before the ergotine mixes with the blood sufficiently to excite the rythmic centres, but that being done, the action is simply augmented, or else occasionally it becomes so violent that the intervals are obliterated, and one contraction becomes merged in another, so that an intermittent is converted into a continuous uterine action.

But that which more certainly demonstrates that the rate of the motions, whether rythmic or constant, is dependent on the kind and extent of irritation, is the variation in the results obtained by different modes of inducing premature labour. If, according to the method of Kiwisch, water is injected simply against the cervix, after several repetitions, rythmic action is slowly excited. If the cervix is distended by the introduction of a sponge tent, rythmic action ensues more quickly and certainly. But if the first proceeding is so varied that the water, instead of being merely thrown against the cervix, is introduced between the membranes and the uterine walls for a very short distance, so as gently to effect their separation from the inner surface of the uterus, labour is induced with greater certainty and speed than in any other way; but should the separation be carried still further, some such tumultuous form of labour results as ergot produces when acting in the manner just specified. The uterus acting continuously and very energetically rather than intermittingly.

Influence of the different nervous centres upon the uterus in parturition. — In the present unsettled state of neural physiology, especially in

* Paget, Croonian Lecture; Proceedings of Roy. Soc. vol. viii. No. xxvi. 1857.

relation to the powers of the different nerve centres, it is scarcely possible to arrive at any satisfactory conclusion regarding the relative degrees of influence which these may be supposed to exercise over the movements of the uterus. The marked differences of opinion still existing upon this subject* afford sufficient evidence of the uncertainty of the data upon which definite conclusions can be based. In this uncertainty, however, all points of the nervous system are not equally involved.

The amount of influence of the cerebrum upon the act of parturition can be determined with tolerable accuracy. That the uterus is in communication with the brain is proved by the fact that the woman is conscious of the fœtal movements, and that she suffers pain when the uterus contracts. Emotion may excite, and may also for a time delay, uterine action. The will cannot operate directly upon the uterus, either in the way of producing, or of restraining its contractions, but a slight indirect influence may be occasionally perceived, when by voluntary changes of posture, or by the use of those muscles which assist labour, the force of the uterus is slightly increased; or conversely, when, by carefully restraining all such movements and actions, this result is avoided.

It is further shown by the occurrence of labour in cases of complete paraplegia, and also during states of unconsciousness, induced by anæsthetics, that the uterus contracts while it is withdrawn from all volitional and like cerebral influences.

These several examples serve to show to what extent the contractions of the uterus may be influenced by the cerebrum, and also how that influence may be withdrawn. It is obvious that psychical influences are neither necessary nor accessory to the simple act of labour. They may often be regarded as disturbing, but not as regulating forces. Hence the dominant power over the contractions of the uterus, which is exercised during labour, must have its seat in some of those nervous centres that are placed lower than the cerebrum.

We may therefore proceed next to inquire what are the attributes which from direct observation and analogical reasoning the uterus may be supposed to derive respectively from the ganglionic and spinal systems, regarded as separate sources of motor power. But here, on account of the intimate manner in which the nerves derived from each of these centres are bound up together, great difficulty arises in distinguishing between the operations of each, and these difficulties can be only in part surmounted.

The circumstances which point more particularly to the influence of the ganglionic system will be first considered.

The uterus derives a greater proportionate supply of nerves from the ganglionic than from the spinal system. This appears from the researches of both Snow Beck and Kilian. The actions therefore of those parts or organs having like endowments, which are in other respects also comparable with the uterus, may be here examined.

Of all organs the heart is that which most nearly resembles the uterus. It constitutes, after the uterus, the largest hollow muscle. Like the uterus, it acts with rhythm, and, in a certain degree, peristaltically. It continues its contractions, with little, if any, interruption, for a long time after its principal cerebro-spinal connections have been destroyed, as by tying the pneumogastric nerves. It continues to contract rhythmically in many animals for a variable time after death, or when cut out of the body. Its contractions are regulated mainly by sympathetic ganglia, while the cerebro-spinal fibres which it receives serve to establish relations between it and other parts.

The uterus exhibits many like peculiarities. It acts with rhythm and peristaltically. It continues these actions, in numerous species of animals, for a variable time after death. Even in the human subject, a post-mortem power of contraction seems to be occasionally retained, as in the case of women whose spontaneous delivery has taken place some time after all evidences of somatic life have ceased.* In these several offices we may conclude that the uterus also, so far as its operations are under the dominion of the nervous system, is, like the heart, chiefly influenced by sympathetic ganglia and nerves.

That this is the case is also further shown by the occurrence of delivery under circumstances in which *all* spinal influence appears to be abrogated. The following is an example.†

A woman was attacked with paraplegia in the eighth month of pregnancy. She had neither sensation nor motion in any part below the umbilicus. No reflex movements whatever could be produced by tickling the soles of the feet. The fæces passed involuntarily, and the urine was drawn off daily. About the ninth month, her medical attendant, when about to pass the catheter, found a full-grown fœtus in the bed (dead). The uterus was contracted, and the placenta in the vagina. The

* See *Tyler Smith*, Parturition and the Principles and Practice of Obstetrics; and Lancet, 1856. *Scanzoni*, Lehrbuch der Geburtshilfe. *Brown-Séquard*, Physiology and Pathology. *Carpenter*, Principles of Human Physiology; and *Todd*, art. Nervous System, in this Cyclopædia.

* A large number of these cases has been collected by Dr. W. H. Wittlinger, "Von der nach dem Tode der Mutter von selbst erfolgenden Geburt," in the Analekten für die Geburtshülfe, Bd. I. 1849. All cases of *post-partum* delivery are probably due to one of three causes, viz., to a contractile power or irritability remaining in the uterus after death, and comparable to that which in voluntary muscles produces the now well-known *post-mortem* cholera movements; to *rigor mortis*; or to the development of gases within the abdomen or uterus, causing the expulsion of the child by pressure. The first is probably the cause of birth within a few hours, and the last several days, after the death of the mother, and the second of the expulsion of the fœtus before decomposition has set in, yet at a later period than can be accounted for upon the first hypothesis.

† For this case I am indebted to Mr. Paget.

woman was entirely ignorant of what had occurred. Scanzoni and Chaussier relate similar examples of birth taking place notwithstanding complete paralysis of the sensitive and motor functions of the lower half of the body. In Chaussier's case the pressure was occasioned by a hydatid cyst which involved the chord on a level with the first dorsal vertebra.*

On the other hand, that the uterine movements are also *capable* of being influenced by spinal fibres, appears from the following considerations. Uterine contractions may be excited by the application of cold to the general surface of the body, or by placing the child at the breast; by injecting warm and stimulating fluids into the rectum, and in other like modes.

Again: the uterus, under various circumstances of health and disease, is observed to react upon all or several of the parts just named.

Hence it appears that a mutual relationship is established, by virtue of which the uterus may be either the excitor of actions in these parts, or may through them be itself excited to action. And there can be no doubt that the spinal cord is the agent through whose reflex operations these several effects are produced.

From this evidence it may be concluded that the double supply of nerves answers different purposes. That the *spinal* system furnishes nerves for the purpose of bringing into harmonious relations all those organs whose cooperation with the uterus is essential or accessory to various steps of the reproductive process. While the organ deriving also a similar or even larger supply from the *ganglionic* system, these nerves serve to regulate the functions which the uterus itself is capable of discharging without cooperative aid. In this view the offices of the spinal system, as a system of relations, and of the ganglionic, as a system presiding over the direct acts of the parts which it supplies, may be separately exhibited. It is doubtless also a chief office of the ganglionic system to regulate and control the action of the blood-vessels with which the uterus is so largely supplied.

What is the exciting cause of labour?— This question carries us only one stage further in the preceding course of inquiry: and the reply to it will be nearly found in the facts already stated. For if these serve to throw light upon the causes of the rhythmic and peristaltic movements of the uterus, then the conditions which determine the first rhythm and first peristalsis, or, in other words, the beginning of labour, cannot lie very remote from these.

Many circumstances may evoke the first rhythm, which being followed by others, labour becomes established. Thus, irritation of incident nerves in various parts and organs may so force those sympathies with the uterus which, for other uses, are established by the spinal system of nerves, as to bring on an unnatural and premature form of labour;— but this is not the present question.

The determining causes of natural labour can be only satisfactorily sought among that class of phenomena which causes the separation of the ripe fruit from the stem which bears it: in a perfecting, namely, of the fruit or product of conception, so that it becomes fitted for an independent existence, and as a step preparatory to this, in a gradual metamorphosis of those tissues which, having served for a time the purpose of connecting the two together, are now no longer required by either. This connecting medium in the human subject is the decidua, which lines the whole uterus. Its metamorphoses during pregnancy have been described. Already as early as the middle of that period, the preparation has begun for a new tissue, which, after labour, is to reconstruct the lining membrane. The old attenuating and perishing decidua, now no longer needed, except at the spot where it

* Cases of paraplegia have sometimes occurred in which artificial aid appears to have been needed to complete the delivery, as in a case cited by Brachet (Fonctions du Système nerveux ganglionaire, p. 266. 1830). By those who contend for a preponderance of spinal influence over labour, such cases are cited in proof. It is said that notwithstanding the complete loss of sensation and motion in the extremities, independent reflex operations may still be preserved in the uninjured portion of the chord. But the motions which may be occasionally excited by irritating paralysed limbs are "disorderly and purposeless," and are in no way comparable with those co-ordinated actions that characterise natural labour. Moreover, the argument is entirely inapplicable to the case cited in the text, in which no reflex action whatever could be produced. It has also been supposed that an essential distinction may be drawn between cases in which the disease is situated high up, and those in which it occupies a lower situation: in the latter cases the portion of chord supposed to furnish spinal nerves to the uterus being involved in the disease, and in the former not. But such conclusions can be of little value until the precise limits of the chord, whence spinal fibres can be derived to the uterus, have been anatomically determined. (See the account of the origin of these nerves at p. 641.)

For like reasons it does not appear that in the present state of neural physiology in relation to the uterus, satisfactory conclusions can always be drawn from experiments upon animals. For although it might seem probable that in a case of mixed nerves, by destroying the centre or origin of one of the sets, the functions of the other might be left unimpaired; or by stimulating one of the nerve centres alone, their actions would be exclusively called forth, while the rest would remain passive; still, absolute conclusions cannot always be arrived at, even in these ways. For in the latter case, on account of this very intermixture of nerves, whenever we attempt to stimulate ganglionic centres, or plexuses, we are dealing at the same time with the spinal fibres which pass through them. Or contrariwise, when we endeavour to destroy extensive tracks of spinal centres, we do not know if the arrest of labour that may follow is not due to the violence which, in most of these experiments, has caused the death also of the animal within a few hours or days after, rather than to the destruction only of the portion of spine whence uterine fibres are supposed to be derived. In this way, perhaps, we can explain those discordant results of experiments, in some of which labour has been arrested, and in others has not apparently been interfered with, so far as uterine action alone is concerned, after greater or less injury or destruction of the chord.

covers the placenta, loses by degrees the character of active vitality, and its tissues are converted into molecular fat.

Other and corresponding changes, of which an account will be hereafter given (see PLACENTA), occur in those structures in which the fœtal blood circulates. The profusely developed capillaries which ramify within the villi during the early and middle periods of gestation begin to suffer retrogression as the time of separation approaches, and the fœtal blood flows in more simple and relatively fewer channels, while, not unfrequently, entire villi become obliterated by calcification.

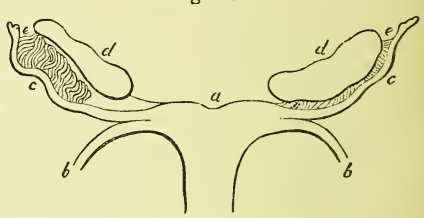
While these changes are proceeding in the temporary structures that serve to connect the fœtus with the uterus, structures which begin in part, at least, to become effete, even before the offices for which they are formed have been fully carried out,—the tissues which are to be employed in the process of expulsion are as yet only ripening into full strength, although they also, in turn, are about to suffer a like retrogression, but not until the object of their formation has been accomplished. The contractile fibre, which constitutes the principal portion of the uterine tissue, has gradually, during pregnancy, advanced to that more complete form which is reached commonly about the sixth month. From this period probably no new development of muscular fibre takes place, although that which is already formed appears to increase somewhat in size and power. It constitutes now a contractile tissue, capable of exerting great expulsive force. How easily, and in how many ways, the contractile power may be evoked, has been already shown. It is probable that by the series of metamorphoses already enumerated as occurring in the parts which connect the fœtus with the uterus, the entire ovum becomes gradually placed in the position of a foreign body within that organ; a position which may be compared to that of the food within the alimentary canal. And just as the food is propelled onwards, peristaltically, by irritation of successive portions of the containing surfaces, until, with the subsequent cooperation of muscles acting under the dominion of the spinal cord, it becomes finally ejected; so the ovum is itself apparently the excitor of those first peristalses in the uterus which initiate labour. How these become coordinated and established, and how the rhythmic periods are probably determined, has been already considered, as well as the means by which, during the further advances of the child over successive portions of the generative track, other nerve and motor forces are added to those with which the process commenced.

Abnormal Anatomy of the Uterus.

A. *Defective development.* — Imperfect or defective development of the uterus may occur under two circumstances. There may be either an original defect in its organisation, arising from a failure of growth or imperfect formation of those portions of the generative canal out of which the uterus is developed; or else the organ, having been regularly formed during embryonic and fœtal life, may not have proceeded in its development, but may have retained the infantile character after the usual age of puberty has arrived and passed.

1*st Class. Congenital defects.* — Defects of this class may affect the uterus alone, or may be conjoined with corresponding imperfections of other organs. In order that their nature and origin, as well as the possibility of their occurrence, independently of any malformations of the other reproductive organs, may be clearly understood, it is necessary to remember the mode in which the uterus is originally constructed. Formed by the coalescence of

Fig. 460.



The entire internal generative organs, from a fœtus of three months. (*After J. Müller* × 8.)
a, uterus; *b*, round ligaments; *c*, Fallopian tubes; *d*, ovaries; *e*, remains of Wolffian bodies.

the inferior extremities of the ducts of Müller*, the uterus will be materially modified in its construction according to the degree of perfection of those ducts, as well as by the amount of union which has taken place at their lower terminations.

Taking these particulars as affording a basis for classification the malformations of the uterus which are dependent upon original vices of formation may be arranged in four groups, viz.: —

Group 1. The ducts of Müller being both imperfect or undeveloped, there results a more or less complete absence of the uterus. The examples of total absence of the uterus which have been recorded are probably cases in which the rudiments exist, but have been overlooked, on account of their slight development; for generally there may be traced a more or less distinct fold of peritoneum lying behind the bladder and representing the broad ligament, within which are found some indications of a uterus. These rudiments consist of two uterine cornua, either conjoined at their lower extremities, or remaining separate in their whole course. They usually occur under the form of two hollow rounded cords or bands of uterine tissue, extending upwards towards the ovaries, and united perhaps at the usual seat of the uterus by cellular tissue, with which some uterine fibres are intermixed. Sometimes one or two little masses of uterine tissue are found. These are either solid, or they contain a small cavity

* See p. 642.

lined by mucous membrane. This constitutes the condition designated by Mayer the *uterus bipartitus*. The concomitants of this condition may be a short vaginal cul-de-sac, together with rudimental Fallopian tubes, and perhaps well developed ovaries. In the latter case the external organs may be well formed, and there may be no deficiency of sexual character, or the vagina may be entirely wanting.

The coexistence of this rudimental uterus with ovaries well developed is easily explained. For the ovary is formed out of a separate portion of blastema from that from which the Wolffian bodies and excretory duct of the generative apparatus are developed, *fig.* 400. and 416., so that the failure in growth of the one does not necessarily involve a corresponding defect in the other.

Group II. If one uterine cornu retains the imperfect condition last described, while the second undergoes development, the one-horned uterus or *uterus unicornis* is produced. So that the organ here consists of a developed and an undeveloped half combined.

The developed uterine horn may be either the left or the right. It then consists of a cylindrical or fusiform canal or body, curved outwardly in the form of an arch which exhibits various degrees of deflection from the meridian. To its upper extremity is usually attached a tube leading to the seat of a well-formed ovary.

The second or undeveloped cornu, with its tube, is not always entirely deficient; but there often exists a rudiment in connexion with the developed horn, which, according to the degree of malformation, is either solid or hollow, or is traversed by a canal opening into the cervix of the developed half.

In the case of the uterus unicornis, notwithstanding the imperfection of one uterine half, both ovaries may be found alike developed.

The type of this condition of uterus exists as a normal formation in the class aves, where one side only of the generative apparatus proceeds in its growth, and the other remains undeveloped from an early period of fœtal life.*

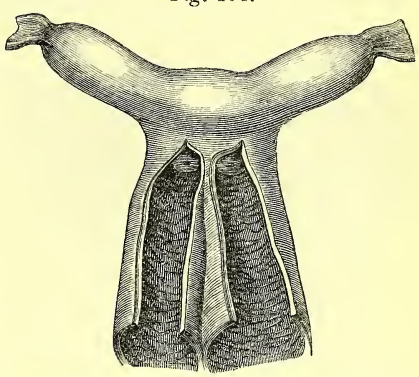
Group III. If, instead of an unsymmetrical growth of the two uterine cornua, such as occurs in the last example, both sides are alike developed, yet without any, or with only an imperfect, junction of their lateral borders there is produced a *uterus bicornis*, falsely termed a double uterus (uterus duplex). Here however there is no evidence of plurality, or true duplicity of the uterus, but only a deficiency of that union of the two separately formed halves by whose subsequent conjunction the organ is normally constituted.

This conjunction should naturally commence from the level of the point of attachment of the round ligaments, and the variations in the degree of malformation will be according to the height at which the union of the uterine halves stops short of that point.

The highest degree of malformation in this group, or the greatest departure from the normal form, is that in which the two uterine halves do not coalesce at all, but remain completely divided in their whole extent. This happens very rarely, and is co-existent with other malformations, such as fissure of the abdominal and pelvic walls. The division is here so complete that certain of the pelvic or abdominal viscera may occupy the space between the two uterine halves.

In the next degree of this kind of deformity a horizontal commissure occupies the angle in which the two uterine halves meet, and serves to unite them together (*fig.* 461.). The

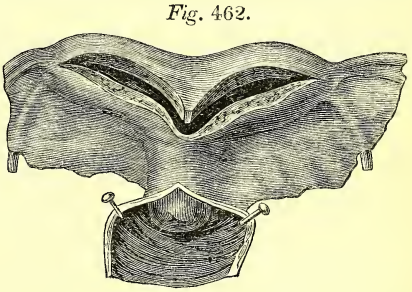
Fig. 461.



The body of the uterus divided into two halves, which are united at the cervix by a horizontal commissure representing the fundus. The os uteri and vagina are double. (*After Busch.*)

horizontal commissure is composed, like the cornua, of uterine tissue, and represents the fundus uteri. According to the height at which it is placed, the external form of the uterus approaches or recedes from the normal type. Rokitansky* has pointed out how the situation of this commissure affects the angle in which the two cornua meet, and consequently the relative mutual position of the two uterine halves. The nearer the point of co-

Fig. 462.



The vagina, os uteri, and cervix, single. (*After Busch.*)

The body of the uterus forming two cornua, which are still nearly horizontal, but are united by a commissure at a higher point than in *fig.* 461.

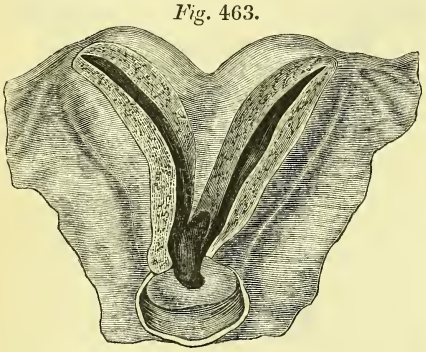
* See Fallopian tube, p. 613.

* Loc. cit. p. 274.

alescence of the two halves approaches to the external orifice, the more obtuse will be the angle at which their junction takes place, and the more extensive will be the fissure (*fig.* 461.). On the other hand the higher the point of union, the more acute will be their angle.

This becomes obvious in the lesser degrees of deformity represented in *figs.*462. and 463. In *fig.* 462., although the commissure is placed at a higher point than in *fig.* 461., so as to be much further removed from the external os, there is still a considerable separation of the two cornua, and their direction is still mainly horizontal ; but in *fig.* 463., where a more perfect coalescence of the two halves has taken

Fig. 463.



The cornua more completely united externally, and the two halves becoming more nearly parallel. (*Ad Nat.*)

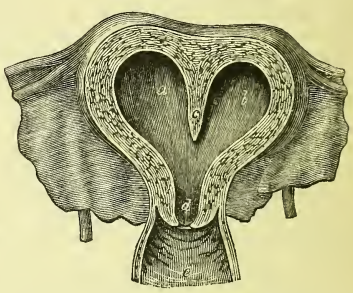
The body is still divided by an internal septum which descends from the commissure as far as the commencement of the cervix, where it ends in a thin falciform edge.

place, and, consequently, where the commissure approaches nearer to the points of attachment of the Fallopian tubes and round ligaments, the angle has become so much smaller, that the two halves begin to lie nearly parallel with one another, and the horns, or ununited portions, exhibit only a slight divergence.

In this, as well as in the following group of malformations, there often proceeds from the commissure an internal septum which descends to a variable depth, and exercises a corresponding influence upon the separation of the two halves. In cases where the commissure representing the fundus lies very low, there may be no septum, and a single cervix conducts into two uterine halves which lie right and left of it. In cases where the fundus is higher, if the septum extends downwards only in a slight degree, as in *figs.* 462. and 464., the cervix is still common to both sides of the uterus. Where the septum begins to divide the cervix, as in *fig.* 463., the separation of the two uterine halves is more complete, but there is still a common os externum, leading to the two canals. The highest degree of division, and consequently lowest type of structure, is that in which the septum extends not only through the cervix, but even to the extremity of the vagina, dividing the latter, *fig.* 461., together with the hymen in the virgin state, so that there are two complete canals leading to corresponding uterine halves.

Group IV. In this group the external form of the uterus differs but little from the normal character. The breadth of the organ, especially between the points of entrance of the Fallopian tubes, is usually greater, and the fundus, though arched, is more shallow than usual. Here also a slight notch, extending into a shallow furrow, running along the posterior uterine wall, may indicate the seat of that internal vertical septum which more or less completely divides the uterine cavity into two halves, and constitutes the *uterus bilocularis* (*fig.* 464.).

Fig. 464.



The body of the uterus showing only a slight indentation externally. (*After Busch.*)

An internal septum *c*, divides it into two loculi, *a* and *b*. The cervix, *d*, is single.

The extent of this septum, and consequently the more or less perfect formation of two separate loculi, exhibits the same varieties as in the former group. The partition may stop short at the cervix, or extend in rare cases completely through that canal, and even divide the vagina. Where the septum is rudimental, and extends only to the cervix, the lower free border is usually thin and falciform (*fig.* 463.), having its concavity directed forwards, the lower extremity being that which is connected with the posterior uterine wall.

These several deviations from the normal form of the uterus will more or less influence the manner of performance of all its functions.

The acts of *menstruation* and *insemination* are those perhaps which are the least disturbed. Regarding this former function, wherever the ovaries are perfect and a channel exists for the menstrual fluid, as, for instance, in the one-horned uterus, the external escape will occur as usual ; but in the case of atresia of the vagina, and in those examples of a hollow rudimental uterus, the menstrual blood collects, and distending the closed sac forms there a hæmatometra.* Where the parts representing the uterus are entirely solid,

* See p. 697.

the menstrual molimen may not be thereby hindered, but the escape of blood can only take place, if at all, from some unsuitable situation producing the so-called *menses devii*, or vicarious menstruation.

Regarding the influence of these malformations upon insemination and a resulting impregnation, much of necessity depends upon the condition of the vagina; for this canal may be in so rudimental a state as not to admit of intromission. The canal leading to the ovary also may be either open or closed. In the case of the rudimental tube attached to one side of a single developed cornu, the passage may open into the cervix of the developed half, and thus a channel for the seminal fluid will be established in connexion with an ovary that may be normally formed, and thus impregnation and gestation, even in an undeveloped cornu, is possible.*

Greater difficulties and considerable danger indeed to life arise, during the progress of *gestation*, in the higher deformities of this class. Pregnancy in a rudimental horn would probably be attended by rupture and fatal hæmorrhage at an early period, as happened in Rokitansky's case quoted in the last note, and as usually occur also in the not dissimilar example of ordinary tubal gestation. But even in the case of pregnancy occurring in the developed horn of a uterus unicornis, the undeveloped half will exercise a marked influence upon the progress of gestation, by impeding the due expansion of the developed side; while the supply of blood usually furnished in pregnancy being here provided by only one set of vessels, the course of the pregnancy will probably suffer in a corresponding degree.

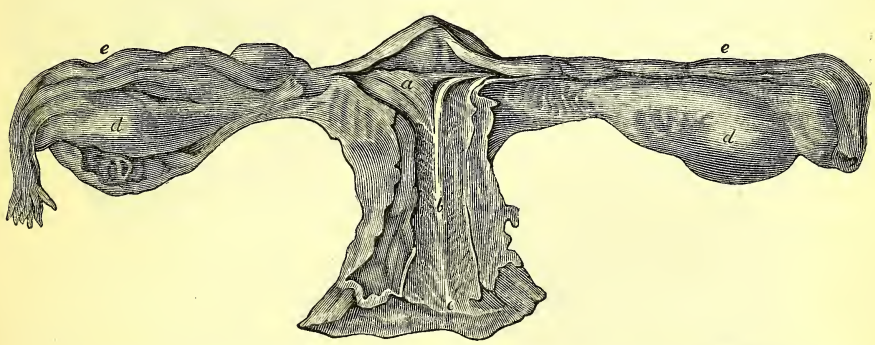
In the cases of the uterus bicornis and bilocularis, either horn, or either uterine half, may become separately or alternately the seat of gestation, or pregnancy may proceed simultaneously in both. There is even reason to suppose that twins have been developed in one half, and also that superfætation has obtained in such a condition of parts.

In those cases where the vagina is partitioned into two canals impregnation may take place more frequently or even exclusively on one side, in consequence of the one channel or half being more favourably formed for intromission than the other.

Regarding the influence which these anomalies may have over the last office of the uterus, viz. *parturition*, it is only necessary to observe that in both the uterus bicornis and bilocularis the organ will be deprived of the advantageous use of the fundus, which so materially aids expulsion in a normally formed uterus, while in the case of the uterus unicornis and bicornis, where the impregnated half usually forms an acute, or even nearly a right angle with the axis of the body, the effect, as Rokitansky has shown *, will be, that during the act of parturition the axis of the impregnated half meeting with the vaginal axis in an obtuse angle, the direction of the uterine force and of the expulsion of the fœtus will cross the axis of the pelvis, and fall upon the pelvic parietes that lie opposite to the vertex of the pregnant half of the womb, and thus the act of parturition will be rendered correspondingly difficult in such cases.

2*nd Class. Defective development after birth. The pre-pubertal uterus.* — The ordinary age of puberty may have arrived and

Fig. 465.



The uterus undeveloped after the ordinary period of puberty has arrived. The cavities of the body and cervix are laid open. (*Ad Nat.*)

a, cavity of the body retaining the triangular form and the lines or rugæ characteristic of infancy; *b*, the cervix, the extent of which is indicated by the penniform rugæ; *c*, anterior lip of the cervix; *d*, ovaries; *e*, Fallopian tubes. From a female aged 19, who had never menstruated. (Compare with *fig.* 442., representing the uterus of an infant. Both these figures are of the natural size.)

passed, and yet no corresponding enlargement or growth of the uterus may have taken place; the organ retaining the form and size which

* See a remarkable case of pregnancy in the rudimentary half of a uterus unicornis, ending in rupture of the sac and death in the third month, by Rokitansky. (Pathol. Anat. Syd. Soc. vol. ii. p. 277.) The preparation is preserved in the Viennese Museum.

* Loc. cit.

characterise it in infancy or childhood. Such may be the condition of the entire internal organs, as in the accompanying example (*fig.* 465.) of the undeveloped uterus from a female aged 19, who had never menstruated. In these cases, the body generally exhibits a corresponding feebleness of growth, and the sexual attributes are little, if at all, displayed.

The infantine condition of the uterus is here exhibited in every particular. The proportionately large size of the cervix, *b*, the small triangular uterine cavity, *a*, with a raphé extending into it, and the thin parietes, are precisely such as are usually found in the infantine organ.

In the last case, the ovaries exhibit also their ordinary infantine proportions; but these may become developed, and the functions of menstruation may proceed naturally, while the external characteristics also are those of a well-formed female, but the uterus remains small, the vagina is short, and instead of terminating in the usual fornix, with a projecting cervix, this canal ends in an aperture, which just admits a sound or probe, and is not furnished with the usual lips of the os tincæ. These cases usually result in sterile marriage, and may be easily detected during life.

Anomalies of form. — Deviations from the ordinary form of the uterus which are acquired during life, and do not proceed from original malformation, or imperfect development, such as that last noticed, will be here considered.

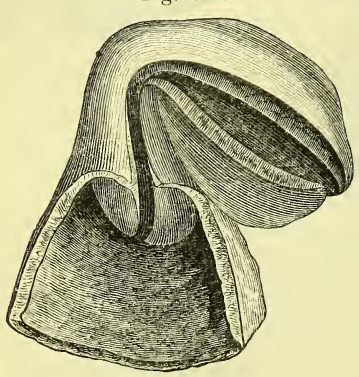
The angular flexions of the uterus which take the definite forms of a forward or backward curve, or of an inflexion towards either side, are distinguished as anti- and retroflexion and lateral inflexion.

a. Antiflexion of the uterus is that condition of the organ in which, without any material change of position in the cervix, the body is bent forwards, so that the fundus, lying more or less horizontally, is directed towards the symphysis pubis, while, according to the degree of inflexion, the anterior wall of the uterus is brought near to, or in contact with, the cervix in front, while the posterior wall looks upwards, corresponding more or less with the plane of the pelvic brim. The point of curvature is always at the line of junction of the body with the cervix uteri, and here an angle more or less acute is formed.

Fig. 466., giving a lateral view of the antiflexed uterus, exhibits the relative situation of its various parts when this deformity exists in the highest degree.

Now a slight amount of antiflexion of the body upon the cervix has been shown by *figs.* 426. and 433. to be natural to the uterus; and it is not until one or two pregnancies have supervened, that this forward tendency, when excessive, is lost, and hardly even then, for the uterus may still retain that correspondence in form, with the curvature forwards of the pelvic cavity, which is so prominently expressed in the curve of the sacrum, and is in accordance with the normal form of the uterine canal. In the fœtus (*fig.* 467.), and during early infancy, antiflexion exists as a normal state, and it appears to me that this bias towards a forward inflexion of the uterus at the early periods of life is given by that remarkable bending forwards of the lower extremity of the spine which is observable in the early embryo. The part containing the structures that are afterwards developed into the uterus exhibits then an abrupt curve, which at this early period will probably be impressed upon the organs within, and being abnormally

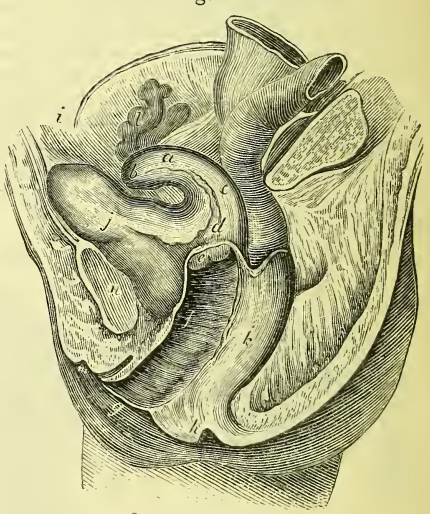
Fig. 466.



Antiflexion of the uterus. (*After Boivin and Dugès.*)

The point of flexure is at the junction of the body with the cervix. Both canals are laid open. (The figure is viewed from the right side.)

Fig. 467.



Natural state of antiflexion of the uterus in fœtal and infantine life. (*After Bourgery.*)

a, body, and *b*, fundus of the uterus; *c*, point of junction of body and cervix; *d*, cervix; *e*, os tincæ; *f*, vagina; *g*, hymen; *j*, bladder; *k*, rectum; *l*, Fallopian tube; *n*, symphysis pubis; *m*, labium.

retained by them after the pelvis has changed its form, may give rise to the malformation under consideration.*

b. Retroflexion exhibits the converse peculiarity, the body of the uterus being bent backwards upon the neck at such an angle that the fundus occupies a position more or less deep between the cervix and rectum, filling and distending the pouch of Douglas. This condition of the uterus ought not to be confounded with retroversion or with those retro-uterine tumours produced by inflammation, and effusion into the cellular tissue (*fig.* 433., G) at the back of the cervix, of which an account will be presently given. See p. 688.

c. Lateral inflexion. — The uterine body exhibits occasionally an inclination to lateral curvature, so that the fundus is directed towards one or other side. A curvature outwards, in the form of an arch more or less deflected from the meridian, has been shown to be the usual condition of the uterus unicornus. But where a tendency towards either side is shown in the otherwise normally formed organ, this appears to arise from some inequality in the development of the two uterine halves; or it may depend upon one half undergoing hypertrophy, so that in either case one uterine angle lies higher than the other, and a vertical line would divide the organ into two unequal parts. The cervix is here curved as well as the body, or the latter may remain perpendicular while the body is bent so as to form an angle with the cervix. The former variety has been designated the retort-shaped uterus.

Anomalies of Position.

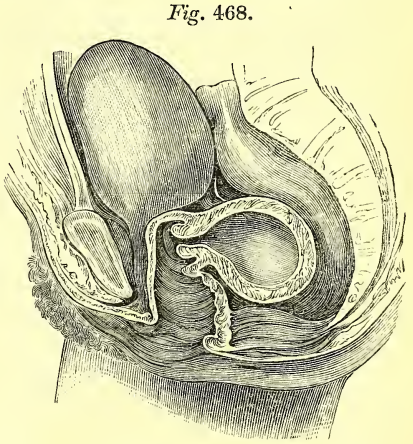
Obliquity of position, Hysteroloxia, Metroloxica, Obliquitas uteri.—The foregoing defects should not be confounded with those deviations in position, without alteration of form, which constitute the various obliquities of the uterus; — like the inflexions of the uterus they are distinguished according as the organ is directed forwards or backwards in the median line, or laterally in the transverse diameter of the pelvis.

a. *Anti- and retro-versions. Situs uteri obliquus anterior et posterior.* — Anti-version of the uterus is by no means so common as retro-version. Both affections differ from the corresponding anti- and retro-flexions of the organ in this respect, that while in the two latter cases the point of flexion is usually at the seat of junction of the body with the cervix uteri, in the former the uterus remains straight or nearly so, while the entire organ is directed forwards or backwards, and the seat of flexion is at the junction of the cervix with the vagina. The displacement of the uterus is here far more considerable than in the former cases.

In *anti-version* the degree of uterine displacement is limited by the bladder and anterior wall of the pelvis, which generally prevent the fundus from sinking so far forwards, as to give the entire uterus in the unimpregnated state more than a horizontal direction. An extreme degree of anti-version however sometimes occurs at an advanced period of pregnancy in multiparæ, on account of an unusual laxity of the abdominal walls permitting the whole uterus to fall forwards, so as to occupy the artificial pouch formed by the pendulous abdomen, the fundus filling the bottom of the pouch, while the cervix and os uteri are tilted upwards and backwards, the latter being lifted out of the pelvis, and pointing above the promontory of the sacrum. This malposition materially impedes labour by reversing the natural direction of the uterine axis, so that the propelling force is expended upon those parts that lie opposite to the os, and the fœtal head is prevented from entering the pelvic brim.

Retro-version occurs in conditions of the uterus otherwise normal, or it may happen when the organ is enlarged by disease or pregnancy. When unimpregnated the displaced organ lies entirely, and when pregnant chiefly, within the pelvic cavity. In retro-version, on account of the excavation of the sacrum, the fundus readily descends so low as to admit of the normal relations of position of the os and fundus being nearly reversed. The latter being directed downwards and backwards towards the coccyx, while the former is tilted upwards and forwards, so as to lie behind, or in extreme cases above, the symphysis pubis. In extreme retro-version a line drawn through the uterine cavity would represent nearly the normal axis of this organ, but instead of passing out backwards through the posterior cervical wall, it will pass out forward through the anterior wall, because the stretching of the vagina in these cases will cause a slight degree of flexion of the cervix downwards. The sequelæ of this displacement in the case of the gravid uterus, when artificial or spon-

Fig. 468.



Retro-version of the uterus. (*Diagram.*)

* See a paper in the Trans. Micr. Soc. vol. v. pl. 7.; Quarterly Journ. Microscop, Scien., July, 1857, in which I have figured a human embryo of four weeks, exhibiting this peculiarity in a marked degree.

taneous reposition cannot be effected, are usually premature expulsion of the ovum or sloughing of the uterine parietes and slow discharge of the contents by fistulous openings into the vagina, rectum, or other parts.

b. *Hernia of the uterus. Hysterocele, Metrocele.* — This displacement is rare. The uterus may escape from the pelvis by some of the natural openings which ordinarily admit of hernia, or by an aperture artificially formed, as, for example, between the muscular fibres of the abdominal walls. In uterine hernia, the displaced organ is often accompanied by other parts, almost always by its own appendages, and commonly by a portion of intestine, or omentum. Uterine hernia may be congenital or acquired. It may occur to the unimpregnated or the gravid organ, and in the latter case the development of the fœtus may proceed to the full extent while the organ occupies this unusual situation.

A careful examination of the recorded cases of uterine hernia leaves it doubtful if the precise form of the hernia has been, or indeed could be, determined in every instance.

Ventral hernia has been observed only of the gravid uterus, which may become, in part at least, included in a large umbilical hernia, or it may result in cases of separation of the recti muscles where the uterus has ascended sufficiently high to fall forwards over the brim of the pelvis. And it has been supposed to occur after the cicatrisation of a supra-pubic abscess, and as a consequence of a Cæsarian section.

Of *crural hernia* an interesting example is given by Lallemand *, in a woman aged eighty-two, whose body he examined. The hernia appeared at the age of forty, after labour. It remained as an irreducible tumour in the right groin, and was twice accompanied by symptoms of strangulation. After death, the sac of the hernia was found to contain the uterus, ovaries, Fallopian tubes, and upper part of the vagina, together with two folds of omentum.

Inguinal hernia. — Chopart † relates a case of hernia in which the uterus with the Fallopian tube and left ovarium occupied a sac beyond the inguinal ring. The uterus was small, flabby, and elongated. Lallemand ‡ gives a corresponding case where the uterus and right tube and ovary were found in a hernial sac on the right side in a woman who lived to the age of seventy-one.

The most remarkable examples are those in which the uterus either became pregnant while so situated, or was protruded during pregnancy.

In two examples of this kind, related by Sennert, the precise nature and situation of the hernia is, perhaps, doubtful, but they are nevertheless very interesting.

In the first, a swelling in the left groin followed the blow of a stick. Soon the swelling expanded, and it became in time evident that this was caused by the presence of a gravid uterus. The tumour, covered by integument, hung forward like an oblong gourd; by degrees movements of the fœtus were perceived, and the woman having at length reached her term of pregnancy, the integument and uterus were laid open, and the child and placenta extracted.

In Sennert's second case, some injury had been received in the first confinement, but it was not until after the ninth delivery that a swelling appeared in the left groin, and gradually increased to the size of a cow's bladder; finally it hung down to the knees. The tumour was opened, and a living child extracted. Both cases ended fatally to the mothers.

The best authenticated case is one which occurred at Salamanca, and is related by Professor Ladesma. A woman, age 42, mother of seven children, and the subject of an irreducible inguinal hernia, when 3 to 4 months pregnant experienced a sudden increase of the tumour after stooping. The swelling, now of a different consistence, could not be reduced, and after a time fœtal movements were perceptible within it. Labour ensuing in the usual way, the liq. amnii escaped per vaginam, but it was necessary to extract the child by incision into the sac. The tumour contracted ultimately to the size of an ordinary scrotum, and formed a permanent hysterocele in the inguinal ring.*

In addition to these forms of uterine hernia, a partial displacement of the organ through the obturator foramen or ischiatic notch appears possible. This latter is distinguished by the not very appropriate title of *hernia dorsalis* uteri.

Prolapsus.—Falling of the Womb.—Bearing down.—Two degrees of this displacement are recognised. In the first the uterus occupies a situation lower than usual, the cervix resting upon or near the floor of the pelvis, yet without any protrusion of the organ externally. In the second, the uterus is protruded partly or completely through the vulva. The former is distinguished as partial, and the latter as complete prolapsus or procidentia uteri.

Prolapsus in the first degree is not necessarily accompanied by any material change in the condition of the uterus itself. The following alterations, however, in its relations to surrounding parts usually result. The whole organ occupies a lower position than usual in the pelvis. The vagina is more or less completely filled, its upper part becoming folded upon itself like the half inverted finger of a glove. The cervix is abnormally directed forwards. The uterine appendages become in part displaced in following the descent of the uterus, while the neck and posterior wall of the bladder, and sometimes a small portion of the rectum, are likewise drawn down on account of their attachments to the cervix uteri.

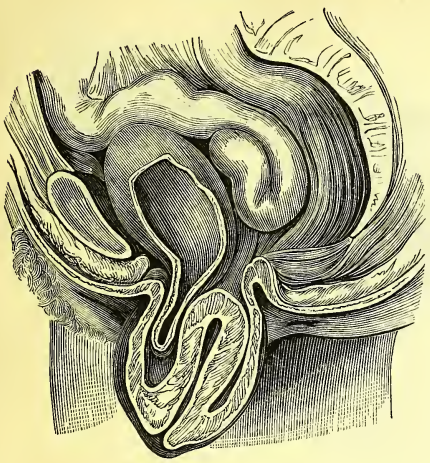
In extreme prolapsus or procidentia, the

* Bulletin de la Fac. de Méd. tom. i. 1816.
† Boyer, Traité des Mal. Chir. t. viii. p. 381.
‡ Mém. Soc. Méd. d'Emulation, 3me Ann. p. 323.

* Edinb. Month. Journ. Pt. vii. 1841.

entire uterus, or a great portion of it, hangs forth beyond the vulva, forming there a pyri-

Fig. 469.



Extreme prolapsus or procidentia uteri. (*Diagram.*)

form tumour of considerable size. At the bottom of this is the os uteri, greatly exceeding in dimensions in chronic cases the ordinary condition of the part. (*Fig.* 472.) The lips are swollen and hypertrophied, and usually present a sore and granular surface on account of the friction to which they are continually exposed. The external covering of this tumour, in all but its lower part, consists of the inverted vagina, the horizontal rugæ of which are very conspicuous anteriorly between the cervix and pubic arch, where a fluctuating swelling is observed, caused by the presence of a portion of the displaced urinary bladder. (*Fig.* 469.) In chronic cases the surface of the inverted vagina gradually loses the character of a mucous membrane, and puts on the ordinary appearance of common integument. After replacement, however, an extensive shedding of epidermal scales ensues, and the surface resumes in time the condition of a mucous membrane.

In cases of great elongation of the cervix, the latter alone may protrude, while the body of the uterus remains within the pelvis. Such a combination of hypertrophy with displacement has passed with the ignorant for an example of hermaphrodite formation.

Prolapsus is the most common displacement to which the uterus is subject. It is frequent in multiparæ, and in women who follow fatiguing occupations, especially those of a relaxed habit of body; but it also happens in nulliparæ. In the latter, when it occurs at an early period of life, it is often associated with enlargement of the uterus or its appendages, whereby both the weight of the organ is increased, and a broader surface is offered for pressure from above.

Elevatio uteri. Dislocation upwards.—This is the converse displacement to the foregoing. The uterus, in consequence of some enlargement of the parts appended to it, as the ovary, or on account of the formation of morbid adhesions, may be drawn upwards to such an extent that no portion of it, or only a part of the cervix, is retained within the pelvic cavity. This displacement is also occasionally observed during pregnancy, and in multiparæ, whose abdominal walls are relaxed, and permit the uterus to incline forward, so that at the beginning of labour the os cannot be reached by the finger.

Inversion. Eversion. — The uterus, either in the unimpregnated or gravid state, may become partially or completely inverted. The conditions which appear ordinarily to combine in producing this displacement, are, first, a distension of the uterine cavity*, as by pregnancy or the presence of a tumour; and secondly, a force applied in the way of pressure from above, or traction from below, whereby the distended uterine walls become folded within each other, somewhat after the manner of the intestinal walls in intussusception. Inversion of the uterus appears always to begin at the fundus which is first depressed into the uterine cavity, and then, under the continued operation of the disturbing forces, the part is gradually protruded through the cervix and os uteri, *fig.* 470., until it emerges in an inverted form into the vagina followed by the reversed walls of the uterine body, and ultimately by those of the cervix. The inversion of the uterus is now complete. The greater part of the organ lies beyond the vulva as a pyriform tumour, the base of which, formed by the fundus, is below, while above the narrower neck of the tumour consisting of the inverted cervix lies in part within the vagina, the upper portion of which canal is also drawn down and partly inverted. The vagina is thus materially shortened, and terminates in a circular fold marking the point of reflexion or inversion, while the usual seat of the os uteri, which is necessarily obliterated, is occupied by the now inverted cervix (*fig.* 471.).

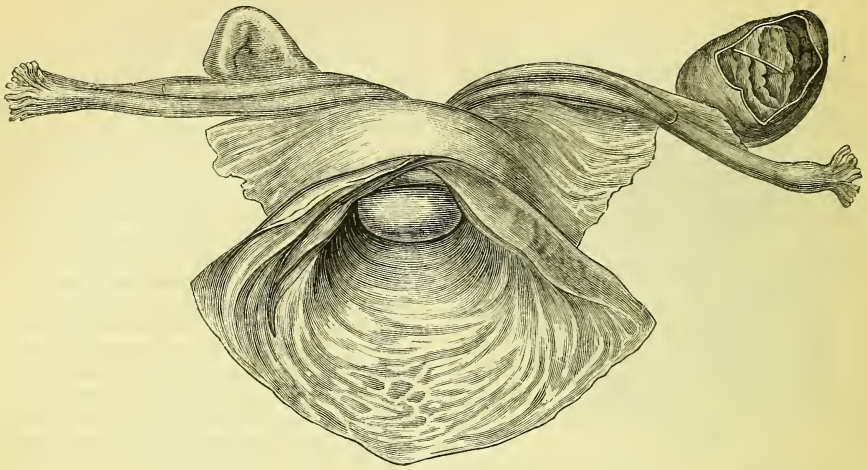
Inversion constitutes the highest degree of displacement of which the uterus is susceptible, for it is both prolapsed and inverted, so that the relative situation of the entire organ to surrounding structures, as well as of all its parts to each other, is completely changed. Inversion does not, however, always proceed to the highest degree, but may stop short at any of the intermediate stages just described.

When inversion occurs to the gravid uterus, the accident usually happens during the efforts of the organ to expel the placenta. In this way, inversion may occur spontaneously, or it may be favoured or produced by injudicious attempts to extract the placenta, or by too much traction applied to the funis. In the unimpregnated uterus, a polypus attached by a stem to the fundus may by its weight slowly produce the same results. That a sudden and spontaneous inversion of the unimpregnated uterus is possible, was proved to

* Boyer, and some others consider that distension of the uterine cavity is not an essential preliminary to inversion.

me in a case which I witnessed of an aged woman whose uterus became completely inverted during a convulsion. In this instance, the only apparent predisposing cause was the

Fig. 470.

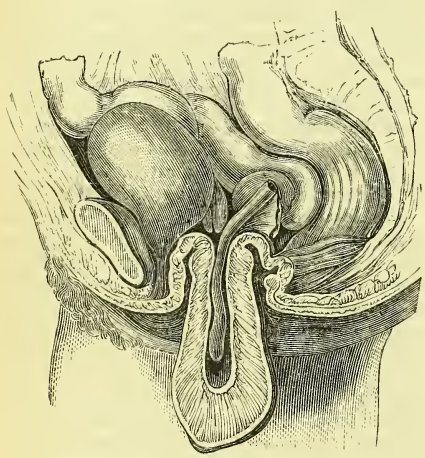


Incomplete inversion of the uterus. (*After J. G. Forbes.*)

The fundus is beginning to protrude through the os uteri, dragging after it the Fallopian tubes, which are drawn into the hollow formed by the inverted organ.

dilatation of the uterine cavity by a tumour the size of a flattened apricot, which was expelled at the moment when the uterus came

Fig. 471.



Complete inversion of the uterus. (*Diagram.*)

down completely inverted, — the violent action of the abdominal muscles and diaphragm probably here producing or aiding the eversion.

After complete inversion, the uterus may remain incapable of replacement. Under these circumstances, the external surface of the protruding portion loses much of its original character of a mucous membrane, and becomes covered by a thicker epithelial layer. It continues, however, more vascular than the surface of an ordinary procident uterus, and is especially liable to abrasion and ulceration, from the friction to which it is exposed. When this displacement occurs during menstrual life, and is permanent, the menstrual fluid may be observed at the periods exuding from the surface of the inverted organ.

The internal relations of an inverted uterus depend upon the extent of the inversion. In extreme cases the interior of the tumour consists of a sac lined by the peritoneum, which originally formed the outer covering of the uterus. The centre indeed of the broad ligament may be said to be inverted so as to form a pouch in which are contained the Fallopian tubes and ovaries, and occasionally a portion of small intestine (*fig.* 471.).

In minor degrees of inversion the uterus remains within the vagina, and the peritoneal pouch in its interior contains only the roots of the uterine appendages (*fig.* 470.).

Anomalies of Size.

a. *Atrophy.* — Under this head may be included those examples in which the uterus appears to have been originally well developed, but has since suffered atrophy of its tissues. Such cases are to be distinguished on the one hand from the imperfectly developed and prepubertal forms already described; and on the other from examples of senile atrophy as it occurs in its ordinary course. Whenever atrophy attacks the uterus before the climacteric change the condition is to be deemed abnormal. Such a wasting may affect the entire uterus or some of its parts. In either case the tissues become pale, soft, and nearly bloodless. In atrophy of the uterine

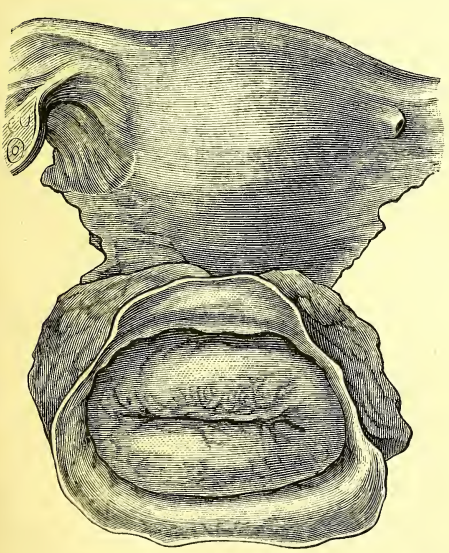
body the walls may not exceed in thickness or density those of the urinary bladder. Such a condition may occur under dilatation of the uterine cavity, which however is more commonly attended by an increase in the thickness of the uterine parietes. The atrophy of the uterine walls which is accompanied by dilatation of the cavity, is distinguished as *excentric*, and that which occurs in combination with a diminished cavity as *concentric* atrophy.

Atrophy of the cervix may be combined with partial atresia of its canal, and is often associated with some malposition or morbid growth of the uterine body or its appendages.

b. *Hypertrophy* is of far more frequent occurrence than uterine atrophy. According as this condition affects the entire uterus or only some of its parts, the organ either presents the ordinary figure but upon a larger scale, or else a greater preponderance is given to one portion, so that the uterus becomes malformed. Hypertrophy of the entire uterus commonly results from frequent pregnancy, from the growth of tumours, or from accumulation of fluid within the cavity. In the latter cases the uterine walls may acquire the same thickness as in pregnancy — and the hypertrophy is due also to the same cause, viz. to a development of smooth muscular fibre, such as ordinarily takes place in the gravid uterus.

Hypertrophy of the cervix is most frequently observed in extreme prolapsus, of which in the chronic stage it appears to be a constant sequence. Here the hypertrophy produces usually a uniform enlargement of both lips, which form together an annular tumour divided transversely by a wide os tincæ, *fig.* 472.

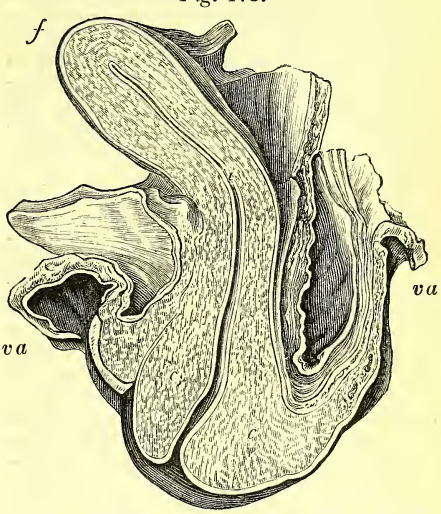
Fig. 472.



Hypertrophy of the os and cervix in prolapsus uteri. (Ad Nat.)

But the cervix may become hypertrophied in the longitudinal direction also. From this there results a remarkable elongation of the uterine neck, which may protrude to a considerable distance beyond the vulva without a corresponding degree of displacement or descent of the body of the uterus. In the accompanying illustration, *fig.* 473, the manner of growth of the elongated cervix is shown. The body of the organ being only partially displaced, a gradual addition to the length of

Fig. 473.



Elongation of the cervix uteri from longitudinal hypertrophy. (Ad Nat.)

f, fundus; *i o*, internal os uteri; *c c*, cervix; *v a*, vaginal walls.

the neck occurs until the vaginal portion protrudes at the vulva. The canal of the cervix may now measure several inches in length. By degrees the protruded part undergoes in addition the concentric and excentric hypertrophy which is common to all cases of procidentia, and the lips gradually acquire the same appearance as in *fig.* 472.

Among the anomalies of size may also be included those examples of imperfect involution of the uterus after pregnancy, in which the organ retains for several months the ordinary size characteristic of it shortly after labour.

Pathological conditions of the separate tissues of the uterus.—Reserving for future notice the affections of the gravid uterus, those morbid states which are observed in the unimpregnated organ will be at present considered. These may be divided into such as belong to (1) the peritoneum; (2) the subperitoneal tissue; (3) the parenchyma; and (4) the mucous lining of the uterus.

1. *Pathological conditions of the peritoneal coat.*

a. The external position of the peritoneal coat, and the small amount which it contributes to the bulk of the uterus, combine to

render the morbid conditions of this coat, regarded singly, of less pathological importance than the abnormal states of the other tissues. The pathological conditions of the serous coat are chiefly those of *acute or chonic metroperitonitis*, terminating often in exudative processes and the subsequent formation of adhesions between those portions of the uterus which are invested by peritoneum and adjacent structures, such as the Fallopian tubes, ovaries, *fig.* 420., small intestines, and the like.

These adhesions are occasionally so extensive as to affect the figure of the uterus, and in most instances they deprive it of its natural mobility, and impede or destroy the functions of the parts or organs appended to it, so that an abiding sterility frequently results. The ovaries becoming invested by a capsule of false membrane, are tied down and atrophied, while the tubes lose their power of motion or their canals become obliterated.

The uterine peritoneum is sometimes alone affected, while the appendages escape. If the inflammation has not proceeded to the formation of bands of adhesion, there may result only some slight processes of false membrane which remain and fringe the surface of the organ. These little fringes or processes, consisting of delicate folds of membrane, often contain vessels which are easily injected.

The peritoneum suffers considerable distension with correlative hypertrophy in the case of tumours which project from the outer surface of the uterus. These become invariably covered by an extension of the peritoneum, which is especially strong about the base of the peduncle occasionally acquired by such tumours.

2. *Pathological conditions of the sub-peritoneal fibrous tissue.*

a. *Perimetritis. Partial chronic metritis. Peri-uterine phlegmon. Retro-uterine tumours.* — The subperitoneal fibrous tissue which connects the peritoneum with the uterine substance, like the peritoneal coat itself, is subject to inflammation. In those situations where the union of the outer and middle coats of the uterus is very intimate, the distinction between a peritoneal and a subperitoneal inflammation may not be possible, but where this connexion is very loose, and is effected by the interposition of a lax fibrous tissue, inflammation may apparently have an independent seat without affecting at all, or with only a partial inclusion of the uterine parenchyma, and sometimes of its peritoneal investment.

The term "*peri-uterine*" has been employed by some authors*, with a view perhaps of avoiding confusion, though at the cost of a solecism, to distinguish these affections from others commonly termed *perimetrial*. In this article, however, inflammation of the subperitoneal fibrous tissue will be designated *perimetritis*, while inflammation of the peritoneum itself, which some include in the latter term, is distinguished as *metro-peritonitis*.

Perimetritis consists in an acute, or more often a chronic inflammation of the tissue, which loosely attaches the peritoneum forming the base of the broad ligament to the proper substance of the neck and lower portion of the body of the uterus. The relation of the peritoneum and of the loose fibrous tissue surrounding the cervix uteri have been described at page 631., where also attention was called to the peculiar lax tissue of this kind which unites the posterior cervical wall with the portion of peritoneum forming the retro-uterine pouch (*fig.* 433. G.). Here, particularly, this inflammatory affection has its seat, although it occasionally extends around the sides of the cervix, so as partially to encircle that part, or more rarely it may involve only the fibrous tissue connecting the anterior cervical wall with the posterior surface of the bladder (*fig.* 426. *b b*, and *fig.* 433. F.).

The anatomical conditions of these perimetrial inflammations are deep congestion of the vessels, accompanied by serous, and occasionally by sanguineous, and possibly fibrinous infiltration of the loose tissue of this part, which, on account of its extreme laxity, readily admits of a great degree of distension. In this way is rapidly formed a tumour which almost invariably occupies the space between the peritoneum and the posterior wall of the uterus, at the point where the body joins the cervix (retro-uterine tumour).

The recognition of such a tumour or swelling during life, by physical signs, is not difficult. The finger introduced into the vagina, so that its extremity reaches the point of reflexion of the posterior wall of that canal forwards on to the uterine neck, discovers, just above this spot, a hard or semi-elastic projection, which seems to grow out of the cervix just at its point of junction with the body of the uterus. The surface of the tumour towards the rectum, upon which it encroaches, is convex, and is either smooth or irregularly nodulated, while between the tumour and the neck of the uterus is usually perceived a notch more or less deep, and comparable in form to that which separates the body from the neck of an ordinary retort. Hence this condition may easily be mistaken for the retorted uterus, which it closely resembles in many particulars. The surface of the tumour is exquisitely tender, while the adjacent uterine structures are free from tenderness.

The comparative frequency of this affection*, and the constant and severe suffering which result from it, especially in married women, in whom it is usually found, may justify here a brief exposition of the peculiar anatomical condition and relation of parts which appear to me to conduce to its production. From the view of the pelvic viscera given in

* Monat, Observation Médicale (Gazette des Hôpitaux, 1850.) Bernutz et Goupil. Recherches Cliniques sur les Phlegmons péri-utérines. (Archives Générales de Médecine. Mars 1857.)

* I believe that it is often confounded not only with retroflexion, but also with retroversion, fibrous tumour, and hypertrophy of the posterior uterine wall, and that hence the frequency of its occurrence has not been commonly recognised.

(*fig.* 433.) it will be seen, that while the normal cervix projects obliquely into the upper part of the vagina, the fornix or blind extremity of that canal forms the actual termination of the tube, so that this arrangement, while it tends materially to the preservation of the os and cervix uteri from injury during congress, at the same time exposes the cul de sac of the vagina to a certain amount of pressure, which various circumstances, such as relative shortness of the vagina and other obvious conditions, may render injurious. But exactly over this spot lies the mass of lax fibrous tissue in question, the meshes of which become easily infiltrated under inflammation by serous or fibrinous fluids supplied by the vessels, which sections of this region show to be so abundant in the neighbourhood. (*Fig.* 429.)

Perimetrial inflammation occasionally reaches the suppurative stage, and in this way are formed some of those abscesses which burst through the cervix, or form collections of matter between the folds of the broad ligament.

3. *Pathological conditions of the muscular or proper coat.*

a. *Diminished and increased consistence* of the uterine substance, although generally resulting from obvious morbid processes, is yet sometimes found without any apparent disease of the tissue.

Diminished consistence may be found in various degrees, from a slight friability or softness to a nearly complete pulpiness (*marciditas*). In these cases the texture of the uterus may be pale and exsanguine, or in a state of hyperæmia, with occasionally apoplectic effusion. Rokitansky associates the latter condition with thickening, and sometimes ossification of the uterine arteries.

b. *Parenchymatous inflammation of the uterus. Metritis. Metritis parenchymatosa.*—Inflammation of the substance of the uterus, which in the puerperal state is so commonly fatal, seldom leads to death in the unimpregnated. Hence opportunities for investigating the anatomical condition of the organ in the non-gravid state under conditions of inflammation are of comparatively rare occurrence. From such opportunities, however, aided by what may be observed during life, the following may be concluded as to the changes which inflammation produces in the muscular and fibrous coat.

Under acute parenchymatous inflammation the whole organ becomes increased in bulk, and at the same time redder and softer. On section blood flows freely from the divided vessels, and the tissues are found permeated by serous infiltration. Sometimes the highly congested vessels have in parts given way, and ecchymoses or larger apoplectic collections have resulted.

If no commensurate resorption of these effusions takes place the organ continues of abnormal size. This is more particularly observable when a portion of the uterus, as the body or cervix, has been repeatedly inflamed. The latter, especially, remains enlarged. The os tincæ is patulous, and one or both lips of the cervix present an œdematous hardness, and occupy a larger space than usual in the fornix of the vagina.

Occasionally inflammation of the uterine parenchyma reaches the suppurative stage, resulting in collections of matter which may escape into the peritoneum between the folds of the broad ligament, or externally by the vagina or rectum.

Chronic inflammation produces likewise a general enlargement of the uterus, but more commonly the cervix is principally or exclusively involved, and the resulting enlargement is especially observable in its vaginal portion, the lips of which become increased in breadth, or elongated and prominent.

When chronic inflammation affects, on the other hand, the parenchyma of the body of the uterus chiefly, the walls of this part become thickened and indurated, while the cavity undergoes enlargement such as is exhibited by the ventricles in excentric hypertrophy of the heart. Under chronic inflammation the uterine tissue becomes indurated, so that upon section it grates beneath the knife. This induration is occasioned chiefly by hypertrophy of the fibrous element of this coat of the uterus.

c. *Fibroid. Tumor fibrosus uteri. Fibro-muscular tumour. Hard fleshy tubercle of the uterus* (Baillie).—These and numerous other titles have been employed by different authors to designate a form of degeneration of the uterine tissue which is so common that, according to the often quoted calculations of Bayle, it may be found in every fifth case of women who die after the age of thirty-five.*

Fibroid of the uterus has for its basis the same structure as fibrous tumours in general.† The surface of a section presents to the naked eye a peculiar mottled appearance, caused by the presence of numerous white lustrous bands intersecting in all directions a more homogeneous basis substance, which in these uterine formations has always a greyish or light brown colour, the latter being especially distinct in spirit preparations. The difference between these two, however, is more apparent than real, consisting, as Paget suggests, rather in the mode of arrangement than in an actual differentiation of the component structures. These consist chiefly of very slender filaments of fibrous tissue "undulating or crooked," and exhibiting various degrees of development in different specimens, being in some large and wavy, and in others very short, and often intermixed with cytoblasts and nuclei. Along with this fibrous basis is found a variable amount of smooth muscular fibre, which in some cases, especially in the polypi hereafter noticed, forms the chief bulk of the

* Dr. West has furnished some interesting statistics upon this subject. (Lectures on the Diseases of Women, Pt. i. p. 277. 1856.)

† For an account of these see Paget's Surgical Pathology, Vol. II. Lect. V.; and also for those of the uterus, Bidder, in Walter ueber firbröse Körper der Gebärmutter.

mass, so that a muscular rather than a fibrous tissue results. A small quantity of elastic fibre is also occasionally found in these uterine formations.

Fig. 474.

Section of fibroid tumour of the uterus. (*Ad Nat.*)

The structural variations observable in fibroid of the uterus, are dependent chiefly upon the peculiarities in arrangement of these component elements. In the more dense formations, the white shining fibrous bands enclosing little pellets of the browner substance, form numerous small compact masses, which are again closely united together by a somewhat looser fibrous tissue that serves to combine the whole into lobes or lobules, varying in size from a pea to that of a man's head. The variation in density of these masses depends, further, upon their vascularity. In the softer kinds, bloodvessels that may be injected permeate the mass, running along the bands and layers of fibrous tissue connecting the lobules. Such tumours are sometimes of a deep red colour. The denser masses, on the other hand, are apparently nearly bloodless; at least, injections cannot be made to penetrate them.

The different configurations which these masses of uterine fibroid assume, appear to depend in a great measure upon accidental conditions. In this particular three varieties may be noticed.

1*st var. Interstitial fibroid.* — The mass here forms a growth, sometimes of immense size, but still contained within the proper boundaries of the organ, occupying one or other uterine wall, but neither encroaching upon the uterine cavity, nor protruding externally. Such is the case represented in *fig.* 475., in which the external appearances were those of the ordinary gravid uterus in the seventh month. Such masses appear occasionally at their periphery to merge gradually into the healthy tissues of the uterus, but more commonly there exists a distinct boundary formed by loose cellular tissue with which the tumour is so lightly connected that it may be easily detached and turned out of its investing capsule (*fig.* 475.).

Fig. 475.

Interstitial fibroid of the uterus. (*Ad Nat.*)

The tumour is formed in the substance of the posterior wall, which is so attenuated at one spot as to be nearly broken through. The cavity of the uterus is shown in the lower part of the figure unaltered in size.

2*nd var. Subperitoneal fibroid.* — In this variety the fibroid mass or masses protrude from the external surface of the uterus. Here one or several round or oval tumours are formed which seem to grow out of the uterine substance by a narrower or broader base, or they remain attached to it by a peduncle. These masses consist entirely of fibroid, having either simply an investment of peritoneum, or beneath that also, in many instances, a layer more or less thick of uterine substance which is usually laminated, so that a capsule composed of the natural tissues of the uterus is formed around the tumour (*fig.* 476.).

3*rd var. Sub-mucous fibroid.*—In this variety the fibroid mass quits its bed in the uterine walls, and projects into the cavity of the uterus; it becomes covered by an extension of the lining membrane of the uterus, and sometimes also beneath this by a layer of healthy uterine tissue. These tumours, when they possess a peduncle, constitute the fibroid polypi of the uterus.

A distinction has been made in these polypi between such as form continuous outgrowths from the substance of the uterus, and those in which the polypous mass forms a discontinuous tumour, connected only by a narrow stem of mucous and muscular tissue.

The original position of the fibroid growth in the uterine walls, whether in the middle or nearer to their inner or outer surfaces, probably determines, in a great measure, the direction and form which these growths ultimately take, and is consequently productive of the three varieties above noted.

The different forms which fibroid assumes are in accordance with these varieties of po-

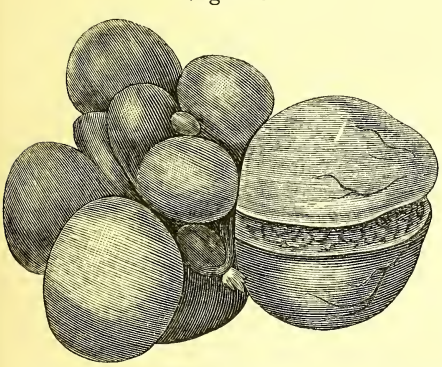
sition. Fibroid growths retained within the uterine walls, are at first almost invariably spherical, but in course of growth become ovate or flattened. Those which project from the outer surface are usually nearly round, while the polypi of the cavity, and those which extend into the vagina, are pyriform, and possess longer or shorter peduncles. The greater part proceed from the fundus, comparatively few from the walls of the body, and scarcely any of this kind from the cervix. The latter are usually of a more spongy or cellular character than the former, which consist of a denser fibrous tissue.

The power of growth of fibroid tumours appears to be nearly unlimited. The known extremes in such cases are, in point of number, from one to forty; and in respect of weight, from a few grains to seventy pounds.

Fibroid exercises a considerable influence upon the form and position of the uterus. Tumours within, or external to it, change the position of the organ in various ways, producing elevation, prolapsus, lateral obliquity, and especially retroversion, according to the seat which they occupy. Polypi distend the cavity of the body and cervix, and the os uteri, and sometimes produce prolapsus and inversion of the uterus.

The influence of fibroid upon the thickness of the uterine walls is also considerable. Generally a marked hypertrophy, equal sometimes to that of pregnancy, takes place, while in parts a thinning of the walls occurs. The latter is especially observable in cases where the tumours are numerous, as in *fig.* 476. These sometimes appear to grow at the expense of the whole uterine substance, so that the original organ is with difficulty discovered among the hypertrophied mass.

Fig. 476.



The uterus surrounded by outgrowths of fibroid which have pushed the peritoneum before them, several having become pedunculated. (*Ad Nat.*)

The uterus, at the expense of whose tissues the tumours are formed, can scarcely be discovered in the midst of the mass.

Important consecutive changes take place during the process of growth of fibroid. So long as the structure retains its original hardness, the increase is comparatively slow, consisting in a simple and uniform multiplication of the elements already described. Occasionally an increase of density is produced by calcification of certain portions of the mass, and in this way the so-called bony tumours of the uterus are formed. Or, on the other hand, under rapid growth, the tumour may become softer, in consequence of serous infiltration into its tissues; the fluid occasionally collecting in the centre of the tumour and forming there a species of dropsy. Or, a process of inflammation being set up, suppuration, and sometimes sloughing, result. In the more vascular fibroids the vessels may dilate and burst, and the tumour then becomes infiltrated with extravasated blood. It has been doubted whether fibroid ever undergoes absorption. I have reason to think, from occasionally witnessing a marked diminution in bulk, that this may sometimes occur. The explanation of this is indeed easy when the mass of the tumour consists of hypertrophied muscular tissue, which in such cases has been found to undergo fatty degeneration, and so its dispersion may be effected.

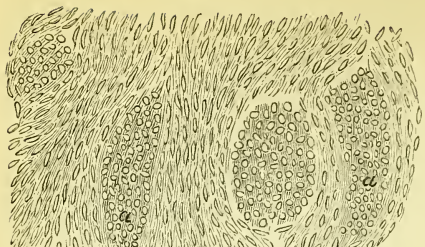
Subperitoneal and interstitial fibroid, when extensive, interferes with pregnancy, and also renders labour difficult or perilous, by weakening the expulsive power of the uterus and predisposing the organ to rupture. Submucous fibroid, in the form of polypi, may prevent impregnation or shorten gestation. In the unimpregnated uterus, all forms, but especially the submucous and interstitial, are apt to be accompanied by severe recurrent hæmorrhage, producing excessive anæmia and occasionally death.

Lastly, it may be observed, in reference to tumours which are commonly termed polypi, that the present state of pathology demands a separation of these, according to their structural differences, such as has long been established, upon a similar basis, among those objects of the animal kingdom whose supposed resemblance, distant indeed, and at the best fanciful, has given a name to this form of tumour. For, as in that prototypal group of animal forms, once termed polypi, three widely separated classes at least are now known to have been combined, so those pathological formations, which are still familiarly termed polypi, exhibit a more than equal number of varieties, each marked by distinct differences of structure. These may be distinguished as the *fibrous*, including the cellular, which are composed of a looser fibrous tissue; the *muscular;* the *mucous*, also frequently containing much fibrous tissue, and the *cancerous* or *malignant* polypi. And to these have been added the so-called *fibrinous* or *blood* polypi.

The fibrous polypus has been already described, and the second, or muscular, may here also be classed with it, as having its origin in the middle coat of the uterus, but consisting of muscular rather than of fibrous tissue.

These muscular polypi are comparatively rare. Their structure, as exhibited in the accompanying *fig.* 477., is precisely that of the proper muscular coat of the uterus.

Fig. 477.



Section of a polypus formed of the muscular tissue of the uterus. (After Wedl.)

The fibres, arranged in bundles, run in different directions. At *a a*, they have been divided transversely, and in other parts obliquely. Compare with *fig.* 436.

The malignant polypi, and those which are formed of hypertrophied mucous structure, belong to another category, and will be described hereafter.

4. *Pathological conditions of the mucous coat.* —*a.* First under this head may be noticed *simple hypertrophy* of the uterine mucous membrane, followed often by a partial shedding of that structure in the form of the so-called

Dysmenorrhœal membrane.—The term *menstrual decidua* would probably form a more appropriate title for these structures, which consist of a greater or less thickness of the mucous membrane lining the uterus, differing in no respect from that membrane in its ordinary condition *, except in the one particular, that it has undergone a certain degree of hypertrophy. (*Fig.* 443.) The hypertrophies which the mucous membrane of the uterus undergoes in various circumstances form a most interesting subject for study, but all of them are not pathological. The most familiar example of normal hypertrophy of the uterine mucous membrane is that which occurs in ordinary pregnancy. Here, no sooner does the uterus begin to enlarge, than the mucous lining also expands, and its tissues become opened up by an increased flow of blood, and a consequent rapid development of the simple elements composing this structure. This hypertrophy occurs in every pregnancy where the ovum enters the uterus. But it also happens very generally in those cases where the ovum never enters the uterus at all, but is developed externally to that cavity (extra-uterine gestation). Here a most perfect decidua is usually found lining the uterus. The exceptions are few in which the uterine mucous membrane, under these circumstances, does not exhibit any increase of thickness, but retains or nearly so, its ordinary characters

* See on the structure of the uterine mucous membrane, p. 635. of this article.

But a state of pregnancy is not necessary to produce evolution of the uterine lining, for this may occur when the body of the uterus is enlarged from other causes. Thus, in an example in my possession of uterine fibroid, in which the body of the uterus has undergone the hypertrophy already described (p. 491.), as common in that state, the hypertrophy has extended to the mucous membrane, so that the uterine cavity, which had also been occupied by one of these tumours, exhibits a delicate decidual lining.

The decidual membranes occasionally cast off from the uterus under circumstances of dysmenorrhœa, consist of fragments, or, more rarely, of entire membranes forming casts of the uterine cavity. The structure of all these is nearly similar, and they differ chiefly in the greater or less thickness of membrane detached. All present upon their inner surface the peculiar cribriform markings already described as constituting the orifices of the uterine glands, while their outer surfaces are rough and shaggy, like the outer surface of aborted ova, for this surface has been detached or torn off from the uterus. *Fig.* 443. represents a portion of such a membrane, as seen from its inner or cribriform surface. The microscopic characters of these membranes are precisely those of ordinary decidua.

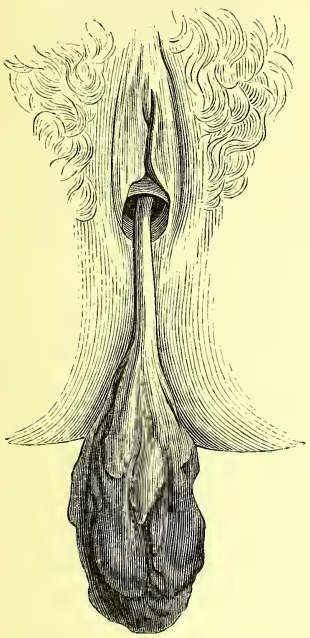
b. Hypertrophy of the follicular structures of the uterine mucous membrane. Follicular polypi. Mucous polypi. Cysts. — The pathological formations which take their origin in the mucous membrane lining the uterus, consist chiefly in hypertrophic growths of that membrane, and of its follicular structures. They present usually two varieties, according as the follicular or the ordinary mucous tissue abounds in their composition. Many of these growths acquire a peduncle, and then constitute the mucous or follicular polypi.

The follicular structure is most apparent in those growths which spring from the body, and especially from the fundus uteri near the orifices of the Fallopian tubes. These vary in size from a pea to a small plum. They have usually a rounded or oval form, and become partially flattened by the external pressure of the uterine walls. A short and narrow peduncle connects them with the spot from which they arise. Externally they are smooth and covered by a layer of epithelium, beneath which is a thin extension of the uterine mucous membrane. This is often sufficiently transparent to render visible numerous opaline spots, indicating the seat of groups of uterine follicles distended and elongated, and containing a semitransparent gelatinous fluid. Between these elongated follicles there is a loose fibrous tissue connecting them together, and giving substance to the mass. These tumours possess little resistance, and are usually soft and elastic.

The more solid mucous tumours very generally acquire a stem, and early take the form of polypi. These mostly arise from between the folds of the lining membrane of the cervix, and are evidently mere hypertrophies

of that structure, including a variable proportion of the sublying cervical fibrous tissue. In size they range from a pea to a walnut, and occasionally their peduncle measures several inches in length, so that they may protrude to a considerable distance beyond the vulva. Their form is generally that of an elongated pear. The surface is smooth, though not uniform, being usually nodulated or lobed, and in parts roughened by minute papillary growths. Sometimes one or two of the cervical folds or rugæ, scarcely altered in character from their ordinary condition in the healthy cervix, are distinctly visible upon them. These more solid tumours are covered by cylinder or pavement epithelium and hypertrophied mucous membrane. Internally they are composed of loose inelastic fibrous tissue, containing a few enlarged and obstructed follicles, one or two of which may grow more than the rest, and form a cavity distended by a slimy fluid.

Fig. 478.



Pedunculated polypus of the cervix uteri. (*After Boivin and Dugès.*)

The growth of both these forms appears to be limited, and they never attain to the size which the fibrous polypi often reach. With the hypertrophies of the follicular structures are also to be classed those single cysts, of the size of a pea, or larger, and sometimes pedunculated, which are very commonly found lying between the cervical folds, or protruding from the os uteri. These consist almost exclusively of distended Nabothian follicles.

c. Hypertrophy of the filiform papillæ of the cervix. — A variety in the condition of the filiform papillæ upon the vaginal portion of the cervix has been described at p. 639. These papillæ, instead of being short, and covered by pavement epithelium up to the very margin of the os uteri, as they are upon the rest of the cervical lips, may present the same condition which they have within the cervix, where they are longer and larger, and are not bound down by a continuous layer of covering epithelium. These papillæ often appear at the margin of the os, and form there little tufts, or extend over the lips of the cervix in the crescentic manner already described at p. 639. They then constitute one of those conditions to which, in the present day, the term ulceration is very frequently applied; yet there is no more reason for asserting that these are pathological formations or conditions, than there is for asserting the same of the villi within the canal, for both are identical in form. They can only be regarded as pathological structures when they obviously exceed the natural conditions already described. Then, indeed, they may be classed among the hypertrophies of special structures of the cervix, and they will bear the same relation to the natural papillæ, that the hypertrophied follicular structures, forming the cysts and polypi recently described, bear to the cervical follicles in a healthy condition. Both the hypertrophied and the natural papillæ give to the finger that peculiar velvety or mossy sensation which is usually classed among the diagnostic signs of ulceration of the os uteri.

d. Simple inflammatory hypertrophy, with extroversion of the cervical mucous membrane. — The mucous membrane lining the canal of the cervix uteri under chronic inflammation becomes frequently partly everted, so that a portion of the inner surface of one or both walls of the neck is rendered visible at the lower orifice, taking here the place ordinarily occupied by the inner border of the lips of the os tincæ. This affection is usually combined with a corresponding hypertrophy of the proper tissue of the cervix, and may be compared in its effects to that thickening of the upper lip common in strumous children, which causes the part to become everted.

Figures 7. and 8. Plate IX. in Boivin and Dugès' Atlas represent an extreme degree of this affection, in which the cervical mucous membrane protrudes to an unusual extent, so that the palmæ plicatæ and middle raphé on both sides are seen. In the more common minor degree of hypertrophy with eversion, a crescentic protrusion only of the cervical mucous lining occurs. The unevenness of the surface, caused by the slightly swollen and prominent rugæ, and as often by the numerous little depressions consisting of enlarged mucous crypts, according as one or the other of these is the predominant normal structure in the cervix *, gives to the part during life the appearance of a raw or granular surface, while

* For a description of these varieties, see p. 640.

the natural boundary between the lower edges of the cervical canal and the lips of the os tincæ being now transferred on to the latter in consequence of this eversion, an abrupt semicircular line becomes visible, which, while it only indicates the natural termination here of the vaginal epithelium (see p. 640.), is frequently mistaken for the margin of an ulcer.

This condition may be observed upon only one lip, or upon both simultaneously. It requires special notice here, not so much for its pathological importance, which appears to me to have been overrated, as on account of certain views of late connected with it, under the belief that it constitutes another form of ulcer of the os or cervix uteri.

e. Catarrhal inflammation of the mucous coat. Endo-metritis. Metritis catarrhalis. Metrorrhœa. Catarrhus uteri. Acute and chronic catarrh. Leucorrhea. Fluor albus.

The ordinary inflammatory affections of the uterine mucous membrane in the unimpregnated state, which were formerly known only by the discharges to which they give rise, and which were consequently confounded with similar affections of the vagina, have in recent times been more accurately examined, and traced to their real seat. That the lining membrane of the uterus, and its cervix in a state of acute or chronic inflammation, is the principal source of many of these discharges, is now well ascertained, and the similarity of these affections to the catarrhs of other mucous surfaces is now also generally admitted. Hence the term uterine catarrh, under the various forms above quoted, has been employed in most recent works on uterine pathology to designate these affections. Inflammation, whether acute or chronic, may involve the entire uterine mucous membrane, or it may be limited to that of the body or cervix.* The ordinary anatomical conditions of this membrane under inflammation are, first, deep hyperæmic congestion, so that the surface presents a uniform florid red colour, or it is mottled with patches of red, intermixed with paler and less vascular parts. In congestion of the mucous membrane lining the body of the uterus, the superficial capillaries, whose healthy forms are represented in *figs.* 439 *a* and *b*, become intensely loaded, so that rupture occasionally takes place, followed by effusions into the substance of the membrane. A serous or sero-sanguinolent, and in more advanced stages, a muco-purulent fluid, covers the surface, while the entire mucous membrane becomes swollen, softened, and infiltrated with serum. An abrupt line of demarcation, when the congestion is limited to the uterine body, marks the boundary between that cavity and the cervix, the lining membrane of which may retain its natural pale colour,—just such an abrupt line of demarcation between the highly congested membrane of the uterine body and the paler lining of the cervix, as occurs during menstruation or in early pregnancy.*

When inflammation affects chiefly or exclusively the cervical mucous membrane, this becomes turgid and swollen, and its vessels congested. The congestion affects more particularly the capillaries of the vaginal portion of the cervix, and of the interior of the canal near the orifice. The lips of the os tincæ are at the same time tumid, the os is enlarged, and the cervical canal expanded; changes which indicate that the structures immediately beneath the mucous membrane are then also involved. A loss of epithelium in the neighbourhood of the external orifice, more or less extensive, may occasionally accompany the severer forms of this affection. From this it results that the turgid and vascular papillæ beneath becomes exposed, and when these are also hypertrophied, the surface acquires the condition commonly termed granular.

The natural or healthy secretions of the cervix become materially altered under catarrh. In a normal state the cervical secretion is sufficient in quantity to cover the mucous folds, and to fill the crypts and furrows, and occasionally to block up the entire canal. It consists of a viscid, tenacious, and nearly transparent fluid, enveloping numerous mucous corpuscles, granules, and epithelial scales.

When the catarrhal state ensues, this fluid is greatly increased in quantity, and, according to the severity of the affection, it passes through the various conditions of a viscid transparent jelly, resembling clear starch or white of egg, of a thicker cream-like fluid, or of a puriform mucus, in colour nearly resembling pus. Blood also is occasionally found mixed with these secretions.†

The ordinary secretions of the cervix, as shown by Dr. Whitehead, have an alkaline reaction within that canal, but they speedily become acid when mixed with the vaginal secretions, which also cause the previously transparent cervical products to become opaque as they pass through the vagina.

Acute specific catarrh of the vagina (gonorrhœa), as well as simple catarrh of that canal, may be associated with the foregoing affections.

Ulceration of the mucous coat. Metro-helcosis. Granular ulcer. Simple erosion, abrasion and excoriation.—These terms have been severally employed to designate certain conditions of the os and cervix uteri, regarding the nature, frequency and pathological importance of which, as is very well known, great diversities of opinion are in the present day entertained.

The affections of the cervix uteri, which

* This distinction, not usually observed by continental authors, has been emphatically made by Dr. H. Bennet. A Practical Treatise on Inflammation of the Uterus. 3d edit. 1853.

* This point, under both these conditions, is illustrated with great fidelity in the coloured delineations of Boivin and Dugès. See Atlas, Pl. I. fig. 4., and Pl. II. fig. 6.

† A descriptive account of some of these fluids, accompanied by illustrations, will be found in the paper of Dr. Tyler Smith, in Vol. XXXV. of the Med. Chir. Trans.

are commonly deemed ulcerative, are admitted by those who so describe them to possess certain characteristic and exceptional features by which they are distinguished from ulcers of other parts. For it is truly asserted, that "whatever the character of an inflammatory ulceration of the cervix the ulcerated surface is never excavated; it is always on a level with, or above the non-ulcerated tissues that limit it, and its margin never presents an abrupt induration."*

Further, with regard to the position of these "sores," two principal circumstances have been almost invariably noticed. As seen by the aid of the speculum, they either present the appearance of a red and apparently raw surface commencing, within the cervix, or at the margin of the os tincæ, and spreading outwardly to a limited extent over one or both lips; or they form numerous isolated red spots, or sometimes depressions dotted at nearly regular intervals over the whole surface of the vaginal portion of the cervix, and varying in size from a pin's head to a millet seed.

It will aid description to take advantage of these peculiarities for the purpose of arranging in two groups or classes the various pathological and other states of the uterine cervix, which severally exhibit the characters just mentioned. Many of these, however, when minutely examined, and tested by the aid of the microscope, so little fulfil the conditions of true ulceration, as to make it appear that such a term could only have been applied to them under, in some instances perhaps a misapprehended, and in others a strained, view of their real nature.

In the first class may be included those cases in which the filiform papillæ of the cervix are in an uncovered state, and either of their natural size or hypertrophied; eversions of the cervical mucous membrane; and hypertrophic growths of the same. All, or nearly all the non-excavated ulcers, so termed, are referable to one or other of these conditions.

Beginning with the normal variety of structure already described, in which the central columnar folds of the cervical mucous membrane take a perpendicular direction (*fig.* 424.), and after running down to the very margin of the os tincæ terminate there in a narrow border, or tuft of filiform papillæ, the simplest form which has been viewed as abrasion, excoriation, or ulcer, is thus produced. The velvety pile, constituting one of the most common features of pseudo-ulcer, being formed by these slightly prominent papillæ, fringing the margins of the os.

In a more marked degree of the same condition, instead of a narrow line or margin, a broader crescentic patch of uncovered filiform papillæ extends outwardly over either or both lips. The papillæ are gathered into little groups, whose appearance, when magnified by a common hand lens, may be compared to miniature wheat-sheaves heaped together. Each papilla is perfectly free and possesses its own proper epithelial coat.* This little group, which may cover half the circumference of the cervical lip, is encircled or semi-encircled by a thin non-elevated margin, where the ordinary pavement epithelium covering the rest of the cervical lip terminates. There is no appearance of any loss of tissue here, beyond that occasioned by the absence of a portion of that dense layer of epithelium, which, like a sheet cast over the papillæ, usually invests them, as far as the inner borders of the cervical lips, with one common covering, in addition to their own proper coat.

These papillæ may retain their normal size, or they may be hypertrophied. On account of the large number of capillaries which they contain, and from the circumstance that they are uninvested by vaginal epithelium, they present a florid and often turgid aspect.

When such a part is brushed over with nitrate of silver, a line of demarcation is instantly produced, the mucus entangled among the naked villi is coagulated, and a cloud of white chloride of silver is precipitated among them, while the parts adjacent which are covered by pavement epithelium are less affected, and exhibit only a pinkish white opalescence, that contrasts with the dead white within, and with the abruptly marked border of the epithelial edge. In this way is produced another effect commonly quoted as a test of ulceration.†

Those bolder and more marked projections of a florid red colour which begin also from the inner margins of the os, and spread outwardly, looking like granulations, consist of hypertrophies of pre-existing structures intermixed occasionally, though more rarely, I believe, with pathological new formations.

Such hypertrophies are chiefly the following, viz. eversion of the cervical lining as described at p. 693.; hypertrophies of the crested folds of that membrane, which when everted, enlarged, and inflamed, constitute the condition termed "cockscomb granulation;" and lastly, distended and closed muciparous follicles gathered in groups around the os and intermixed with the hypertrophied structures just noticed. These latter add to the irregularities and nodosities of the surface, and together with fissures formed by deepened natural folds, and varicose distensions of vessels, constitute the more irregular forms of hypertrophies which have been termed ulcers.

The second class of pseudo-ulcers termed commonly aphthæ and granulations, viz. those which are dotted at regular intervals over the lips of the cervix, but are often more enduring than herpes, and do not usually in their progress coalesce as herpetic spots when contiguous almost invariably do; these consist of

* J. H. Bennet, *loc. cit.* p. 79.

* Regarding the nature of this coat see p. 639.

† Precisely such an effect may be produced upon mucus scraped with a piece of glass from the tongue, and touched with argenti nitras.

enlarged muciparous follicles*, which in three different conditions or stages correspond with three varieties of pseudo-ulcers of the aphthous kind. In the first variety the follicles are closed and project like millet seeds above the general level of the cervix. They contain a little glairy fluid, and may be compared to the distended closed follicles described at p. 640., as occurring within the cervical and uterine cavities. They are almost always placed at such regular intervals apart, that they must be regarded as natural structures enlarged, rather than as pathological new formations.

The second variety consists not of closed but open follicles similarly arranged. Within and at the bottom of many of these may be seen the filiform papillæ enclosed, cup-like, and resembling the stamens in a half opened flower. Similar follicles to these occur sometimes within the cervix under ordinary circumstances.

When these papillæ become hypertrophied and sprout out above the cup-like level of the containing follicles they form florid-looking and elevated spots resembling granulations in appearance, and these constitute a third variety — the "granulations simples sans ulcerations" of Pichard.†

The foregoing examples have been here passed in review for the purpose of illustrating the principal anatomical and pathological conditions of the uterine cervix, which when viewed by the speculum during life exhibit appearances that are regarded by many observers in the present day as affording unmistakeable characteristics of ulceration. With this object they have been here grouped together, but they do not form a class ; many of them indeed have no pathological relationship, and to few can the term ulceration be regarded as appropriate. In order, therefore, to eliminate from the category those conditions which have no title to be considered as ulcers, it is needful to apply to them the test of a definition. With this view, and also for the purpose of avoiding the confusion which from the time of Hunter downwards has attended the employment of various terms for the designation of ulcerative processes, of those at least by which the particles of open or exposed surfaces are removed, it may be well to adopt some such distinction as that proposed by Mr. Paget, namely, to regard as abrasions or excoriations those conditions in which the epithelium or epidermis of an inflamed part is alone removed, and those only as ulcerations in which the removal extends further to the vascular or proper tissues beneath the epidermis.‡

Judged by this test, there may be excluded, first, all those apparent sores which, beginning invariably from within the margins of the os, and appearing to spread outwardly more or less over the cervical lips, present a florid and often granular aspect, and being on a level with surrounding parts, and without definite edges or raised border, fulfil all the conditions commonly assigned to ulcers of the uterine neck. These, almost without exception, consist of the inflammatory conditions already described as hypertrophies and eversions of the cervical mucous membrane. The apparently raw surface exposed to the eye is not usually any portion of the outer cervix, but the swollen inner surface of the walls of the cervical canal now everted and brought into view, just as the interior of the lip is brought into view in common strumous thickening about the mouth. The margin of this apparent ulcer is the normal boundary of the os, or line of demarcation between the vaginal and cervical mucous membrane, now disturbed and thrown out of its natural place. The granulations upon this surface are the thickened and inflamed papillæ, follicles, and rugæ of the cervical canal. The edges are not raised because they simply form the boundary between the vaginal and cervical epithelium, and the centre is not depressed, because there is no erosion nor any loss of tissue.

These conditions of the uterine cervix in respect of their true pathological relations are exactly allied, in their different degrees, to the inflammatory conditions of the eyelid termed respectively Lippitudo, Ectropion and granular lid. Both are attended by like hypertrophies of structure and corresponding depravements of their healthy secretions. Both are reduced to their normal condition by similar or even identical methods of treatment, and both are alike entirely removed from the category of ulcers.

Next to these may be enumerated the conditions of the uterine neck which are distinguished by loss instead of hypertrophy of tissue. When this loss consists solely in detachment of epithelium the term "epithelial exfoliation" appears to be a more appropriate designation and preferable in many respects to "excoriation or abrasion," — terms which seem to imply something of violence in the mode of production of these conditions.

Exfoliation of the tesselated epithelium covering the vaginal portion of the cervix appears to take place under some circumstances with great ease. In uterine catarrh for example, this shedding of epithelium commences at the borders of the os, and extends outwardly. Or it may involve the entire epithelium of the vaginal portion of the cervix together even with that of the vagina itself, these being sometimes thrown off like a cast. In such cases, a fresh epithelium is formed beneath the old one that has been detached.*

But if the epithelium is not renewed the villi remain denuded. This condition may be precisely imitated after death by macerating the part for a few days, and then peeling off

* See p. 640.

† Excellent representations of the varieties described above will be found in Boivin and Dugès' Atlas, pl. 25. 27. and 33., and in Pichard, Mal. des Femmes, pl. 3.

‡ Surgical Pathology, vol. i. p. 419.

* See also page 707. and note.

the epithelial covering. And it is probable that profuse discharges lying in constant contact with these parts during life may similarly assist in softening and detaching this structure. But it is deserving of consideration that the papillæ of the outer surface of the os by this uncovering are merely reduced to the same anatomical condition as those of like form within the cervical canal. Whether this deprivation of a natural covering usually found here renders the villi of the outer cervix, which are probably specially sentient structures, more susceptible of irritation, particularly when in a hypertrophied state, is a matter for consideration that would extend the present inquiry beyond its proper limits here. But it is probable that in this way may be explained those constitutional and local erethisms which often accompany faulty states of the uterine cervix; and which have led to such conditions being invested with a degree of importance often in excess of their true pathological value.

But the villi may be found in some specimens denuded of vaginal epithelium, yet without any evidence of inflammatory or other changes. Such a part may appear quite natural. The villi upon the cervical lips, and those within the canal being in every respect identical and alike natural in appearance, so that the strictest microscopical investigation may fail to detect any difference between them. The examination of such specimens has satisfied me that the vaginal epithelium does not always normally terminate precisely at the inner borders of the uterine lips, but may cease at some point short of this.*

In the third place are to be noticed those cases in which the process of removal extends to tissues deeper than the epithelium, *i. e.* to the villi, the vascular and fibrous, and other tissues. The removal of such tissues here necessarily produces excavation with definite borders, and all the characters of a true ulceration. Ulcers of the uterine cervix exhibiting these features are almost exclusively either syphilitic, phagedenic, cancerous, or cancroid, and such as occur upon the surface of a prolapsed uterus. They are seldom, I believe, scrofulous, and more rarely if ever do ulcers occur upon the uterine neck as the result of simple inflammation, fulfilling the conditions that would entitle them to be admitted into the category of true ulcerations.

Distensions of the uterine cavity, by liquid or gaseous contents, constitute the affections termed respectively *hydrometra*, *hæmatometra*, and *physometra*. These collections result usually from narrowing or atresia of some portion of the vagina or cervix, whereby the natural or morbid secretions of the uterus become pent up in its cavity. They are generally accompanied by hypertrophy, but sometimes by atrophy of the uterine walls.

* Some of these morphological varieties have been described in a preceding page; and such, together with many of the hypertrophies already noticed, have been repeatedly submitted to me during life as examples of ulcers of the uterine neck.

Hydrometra results usually from a combination of chronic uterine catarrh with obliteration, absolute or relative, of the lower uterine orifices. Such obliteration, for example, may be caused by chronic disease of the cervix, by the presence of a submucous fibroid or a cervical polypus obstructing the cervical canal, or by the pressure of an enlarged neighbouring viscus, as the ovary*, or of a chronic abscess. If, with these or similar conditions, uterine catarrh co-exists, the secretion from the mucous membrane collects in, and gradually distends, the cavity; the walls of the uterus becoming at the same time hypertrophied, or sometimes atrophied.† The fluid which accumulates in such cases may be thin and watery, but it is more often puriform, and in some instances, as in Dr. Hooper's example, which resulted from the opening of an abscess into the uterine cavity, it consists of pure pus. To these cases, the term *pyo-metra* would be perhaps more appropriate. Collections of these kinds amount usually to several ounces, or may reach one or two pounds. The uterus enlarges to the size of a fist, and, in rare examples, to the bulk of the gravid uterus at term.‡ Pure hydrometra, *i. e.* without hæmatometra, can only occur after the climacteric period, or in combination with amenorrhœa.

When the inner and outer os uteri are both closed, and the cervical and uterine cavities are at the same time distended, the organ resembles an hourglass in form. This constitutes the *uterus bicameratus vetularum* of Mayer.

Hydrometra is to be distinguished from *hydrorrhœa uteri*, in which there is no obstruction, but a continual escape of a thin, watery fluid, often to a large amount. This condition, which may occur both in the unimpregnated and gravid uterus, is apparently dependent upon excessive activity of the follicular structure of the cervix, and may be viewed as a coryza of that part.

Hæmatometra consists in a collection of blood, usually menstrual, in the uterine cavity. It is commonly associated with atresia of the vagina at some point, generally at the orifice, as when the hymen is imperforate, or when the orifice has become closed by inflammation of the vulva in early infancy. Under these circumstances, when the menstrual age arrives, the fluid, for which there is no outlet, collects in, and distends, the cavity of the uterus, whose walls at the same time become hypertrophied, as in pregnancy; or occasionally attenuated, as in the case of hydrometra just stated. The fluid, which is generally dark-coloured, and of the consistence of treacle, may, if not artificially evacuated, escape spontaneously in various ways, viz. into the abdominal cavity, by travelling along the oviducts, or through lacerated or ulcerated open-

* Scanzoni, *loc. cit.* p. 165.

† Hooper, Morbid Anat. of Uterus, pl. III.

‡ Case. Dr. A. T. Thomson, Med. Chir. Trans. vol. xiii.

ings in the uterine walls; or, if previous adhesions are formed, the fluid may escape by the vagina or rectum. Hæmatometra may occur also in certain malformations of the uterus, as already described (p. 680.).

Physometra. Pneumatosis s. tympanites uteri.—This affection, known to Hippocrates* and Aretæus†, consists in a collection of air in the cavity of the uterus, which makes its escape from time to time by the vagina, with or without explosion. The air may be dry, or accompanied by more or less fluid (*physometra humida*). In ordinary cases it is inodorous, but occasionally it possesses a most offensive odour. In these latter cases (*physometra putrida*), the gas appears to be generated by decomposition of some substance within the uterus, as a putrid fœtus, the remains of a placenta left in utero, and the like, while the generation of an inodorous gas, on the other hand, without the presence of any such substances, within the uterus, can only be compared with those sudden developments of air in the stomach and intestines which often take place in hysterical women.

Hydatids.—A case of acephalocysts within the ovary has been given at p. 584., but this is so rare an affection of the uterus that no anatomical collection, I believe, in this city contains an example of it. Rokitansky's often-quoted case‡ appears to be the only certain instance of acephalocysts in the uterine cavity which pathologists in the present day are able to adduce.

In the "Lancet" of 1840, vol. i. p. 691., a case is reported as one of uterine hydatids, the nature of which is not very clear. That they were not acephalocysts (echinococcus vesicles) may be inferred from the description. This case, which is quoted here as an example of the more doubtful instances of hydatids, was probably one of interstitial pregnancy (see p. 621.) combined with the vesicular degeneration of the chorion described in the next paragraph.

Those vesicular masses and groups or strings of watery vesicles, falsely termed hydatids, which are so frequently expelled from the uterus accompanied or preceded by abundant serous discharges, combined with rapid distension of the abdomen and some symptoms of pregnancy, consist invariably of moniliform enlargements of the villi of an imperfectly developed chorion or placenta.

It is almost needless to observe that the presence of a true chorion structure, which these substances invariably exhibit, even in their most degenerated and abnormal forms§, constitutes unquestionable evidence of a prior act of impregnation. Connected with these, when the degeneration is not much advanced, may be sometimes found an embryo perfectly or incompletely developed*, but in higher grades of this abnormal state the embryo invariably perishes or is unformed.

Narrowing and obliteration of the uterine cavity. Atresia.—The defects which come under this head may be either congenital or acquired. They may consist in a simple narrowing, or stricture of the cavities of the uterus, or of the apertures leading to them, or in a complete obliteration of some or all of these. Probably most of the cases of atresia which do not originate in the malformations already described, have resulted from the organisation of the products of inflammation affecting these parts.

Obliteration of the *external os uteri*, either partial or complete, is the most common of these conditions. In minor degrees, where the form of the parts is not lost in adhesions with adjacent structures, the os is found closed by narrow membranous threads or bands. If the closure is not complete, pregnancy may ensue, but labour is obstructed, and the original seat of the os is then with difficulty traced, or it cannot be found.

The *cervical canal* may be entirely obliterated by the formation of fibrous tissue, in which smooth muscular fibres have been sometimes found.

Obliteration, or narrowing of the *inner uterine orifice*, may occur in the progress of senile atrophy, or as a result of the same processes that cause obliterations lower down. All the foregoing atresiæ may result in the collections of fluids within the uterine cavity recently described.

Lastly, the *cavity of the uterine body* may be so completely closed that no trace of it can be found. Such an example is delineated in Pl. 13. of Boivin's and Dugès' Atlas, which contains also the figure of another uterus, the original seat of whose cavity is indicated only by a narrow triangular band of white tissue nearly as hard as cartilage.

Pathologic conditions which may involve several of the uterine tissues.

Cancer.—The two main disorganising processes by which the structure of the uterus is metamorphosed or disintegrated and ultimately more or less destroyed, are those under which cancer and fibroid are respectively developed in its tissues. Of these, regarded as destructive agents, cancer ranks second in point of frequency, but first in potency.

Cancer occurs in the uterus as in the ovaries, under the three principal varieties of encephaloid, scirrhous, and colloid. But while in the latter organ colloid as a primary disease is certainly more common than either of the other two; in the uterus, on the other hand, both scirrhous and colloid are rare, while encephaloid constitutes the chief form under which cancer is found.

The development of cancer may undoubtedly commence in any portion of the uterus, but the number of instances in which it occurs,

* De Morbis Mulierum.
† De Causis et Signis Morb. Diuturn.
‡ Loc. cit. vol. ii. p. 291.
§ For descriptions and illustrations of these structures see Wedl, Pathological Histology (Syd. Soc.), p. 172.

* Granville, Graphic Illustrations of Abortion pl. iv. and v.

first, in the cervix, and especially in the vaginal portion, is so preponderating, that this may be regarded as mainly the seat of origin of uterine cancer.

The comparative rarity of opportunities for examining uterine cancer in the incipient stage, has limited to a certain extent our knowledge of this part of the subject.

The cervix in the incipient stage, smooth, tense and hard, or exhibiting upon its surface here and there knotty projections, is found upon section to have its tissues infiltrated in parts by the cancerous structure, which differs in the character and relative proportions of its elements, according to the form which the cancer assumes. In the medullary variety a white cream-like or lardaceous semi-fluid matter, composed of the usual cancer constituents, is found interspersed among the meshes of a loose reticulum, in the softer portions of which few if any of the normal uterine fibres can be traced. The larger preponderance of the encephaloid matter, compared with the fibrous stroma, occasions that semi-elastic feel which the part early acquires, and at the same time constitutes the main difference between encephaloid and scirrhous cancer.

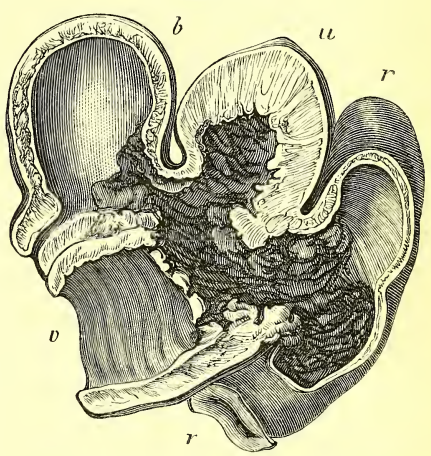
In the scirrhous or fibrous variety the greater hardness of the structures is dependent upon the presence of a large proportion of a coarser fibrous stroma, composed of dense white fibres, the minute interspaces of which are occupied by a greyish or reddish softer and often pulpy substance, which may be obtained by scraping, or may be squeezed from the part. In the harder forms of scirrhous but little fluid is so obtainable; but in some specimens here and there, softer portions are found from which a fluid cream-like matter exudes, differing in no respect from the pulp of encephaloid cancer. These and the softer portions obtained by scraping are composed of cancer cells with molecules, granules, and disintegrated fibrous tissue.

The irregular nodulated projections occasioned by the unequal development of the cancer structure rapidly increase in the encephaloid variety, and the cervix becomes much enlarged. The surface of the more projecting portions becomes florid and vascular, and these portions pass first into ulceration by thinning and absorption of their mucous covering. The creamy or cheese-like contents of these tuberculated portions then escape, and being sometimes of a yellow colour may be mistaken for tuberculous matter.

This stage is followed by the formation of one or more corresponding ulcers upon the outer cervix, which coalescing destroy the remaining portions of the mucous membrane, and spreading up the cervical canal, convert it into an irregular funnel-shaped cavity, bounded below by hard rugged margins. Or fungous vascular growths, friable and easily bleeding, sprout from the part and entirely destroy its natural configuration. A yellow or greenish-brown sanious discharge, of a highly fetid odour, mixed occasionally with florid blood and ultimately with fragments of putrid tissue, dates from the commencement of ulceration, and increases in proportion to the extent of surface denuded. The fragments of putrefied tissue which hang from the ulcerated surfaces, and occasionally pass away in the discharges, consist mainly of connective tissue fibres, which are more slowly disintegrated, stained of a dirty brown colour by infiltration with decomposed blood.

By these disintegrating processes both lips, and finally the cervix itself, are destroyed and removed; the cancer structures being continually deposited in advance of the ulceration, while the fundus and even the body of the uterus may still remain sound. In like manner cancerous deposits take place in the fibrous tissue surrounding the uterine neck, and attaching it to adjacent parts. Thus the uterus becomes fixed in the pelvis, and at the same time a way is paved for the further extension of destructive ulceration, by which first the bladder and then the rectum are penetrated, and the disease further extending down the vagina, the whole is laid open into one ulcerous cloaca (*fig.* 479.). If life is

Fig. 479.



Cancer of the neck of the uterus (*u*), extending to the bladder (*b*), rectum (*r*), and upper part of the vagina (*v*). (*Ad Nat.*)

maintained beyond this point the pelvis becomes lined with cancerous matter, and, the peritoneum inflaming, all the adjacent parts become agglutinated together, until finally the ulceration may extend into and lay open the peritoneal cavity itself.

The penetration of the bladder earlier than the rectum, which almost uniformly obtains, is explained by the different modes of connexion of the cervix with these two parts. Since nothing but fibrous tissue intervenes between the bladder and the anterior cervical wall (*fig.* 426. *b b* and 433 F), the cancer elements are readily deposited, and extended in this direction, while the posterior wall being separated from the rectum by a double fold of

peritoneum (*fig.* 426. 433. g), the cancer matter does not so easily penetrate through this, not at least until adhesions have formed.*

But cancer may commence in the fundus or body, instead of in the cervix, although this is rare; or it may extend to the uterus from the ovary. In this way extensive disorganisation of the adjacent parts may occur, the cervix remaining intact.†

Cancer, when thus developed, especially in the encephaloid variety, assumes often the form of distinct masses or tumours, rather than of an infiltration of the tissues.

These tumours may be imbedded in the uterine walls, or form numerous irregular rounded and sometimes pedunculated masses, variously attached to, or projecting from their surface. On the other hand such a distinct mass formed in the substance of the uterine walls, or beneath the mucous membrane, may in the course of growth push the latter before it, and, subsequently acquiring a stem, may fill the uterine cavity or protrude into the vagina, and constitute a malignant polypus.

In most cases of uterine cancer the uterus is the primary, and except in those instances where the disease has spread by direct extension to adjacent parts, it may remain throughout the sole organ attacked. Or uterine cancer may be associated with like formations in the stomach, mamma, ovary, &c., and be developed concurrently with or consecutively to these.

Cancroid. Epithelial cancer. Cauliflower excrescence.—Cancroid of the uterus is limited in its commencement to the vaginal portion of the cervix, and presents the following principal varieties. It may appear under the form of papillary growths, resembling condylomata, which spring from the mucous surface, and form little compact masses that gradually, by the growth and elongation of the papillæ, become soft, pulpy, and brittle, and easily bleed on being touched. After a time a basis of cancroid is developed in the cervical tissues, or the papillary growth appears upon a larger scale, forming a hard, knotty, and brittle mass, which grows with tolerable rapidity, and ultimately more or less fills the vagina or protrudes from the vulva. In form the growth often resembles a cauliflower, to which it was likened by Dr. John Clarke. The surface is of a bright flesh colour, and is covered with small projections or granules. These again are united into larger masses or lobes, set upon short and broad stems, that ultimately coalesce into a common basis formed by one or both lips of the cervix. The whole tumour has a certain firmness and solidity; but the superficial granules are so brittle that slight handling causes some to break away, a free hæmorrhage resulting. Or the cancroid, after being developed in and beneath the mucous membrane of the cervix in the form of little granular masses, gradually breaks through the surface; while in the course of time ulcerations form upon the most prominent portions, and these coalescing, while increased deposits of cancroid take place in the sublying tissues, which in turn are also destroyed, a sore, more or less extensive, is formed that in its further aspect and progress very nearly resembles encephaloid cancer.

Regarding the structure of these cancroid formations, they are, according to Virchow, at the commencement simple papillary growths, and later assume the characters of cancroid. At first they appear in the form of small villous projections from the surface, composed of an outer very thick layer of peripheral epithelial plates, and an inner one of cylinder ephithelium, the interior of the villus consisting of large blood-vessels. These vessels are chiefly colossal thin-walled capillaries, which either form simple loops at the extremities of the villi between the layers of epithelium, or ramify in compound loops over the surface, or lastly, present a retiform arrangement. The great size, tenuity, and superficial position of these vessels explains the profuse discharge of watery fluid, and frequent bleedings, which constitute such striking features in the progress of the cauliflower excrescence, as well as the entire collapse and almost total disappearance of those tumours after death, so that only slight traces of them are found on post-mortem examination.

At the commencement the papillæ are single and close-set, so that the surface, as Clarke describes it, is merely granular. The peculiar cauliflower form is occasioned by the branching of the papillæ, which ultimately form fringes an inch in length. After this superficial process of growth has continued for a certain time, cancroid alveolar spaces begin to be formed at the base, between the fibrous and muscular layers of the organ. At first these appear as simple spaces, with epithelial contents, but later are found alveoli, from whose parietes new papillæ spring, which also become ramified, constituting arborescent proliferous growths.

Corroding ulcer.—Here may be noticed an affection of the uterine cervix, whose exact pathological relations have not been determined with sufficient accuracy. The corroding ulcer, first described by Dr. John Clarke, and compared by Rokitansky to a phagedenic (cancerous) sore of the skin, differs mainly from cancer in the absence of a cancer basis, or of cancerous infiltration of adjacent tissues, while it resembles the destructive march of cancer in its mode of gradually disintegrating, and destroying the os and cervix, and even portions of the body of the uterus, and extending to the bladder, rectum, and adjacent structures. The characters of this ulcer are those of a ragged, irregular-margined sore, with a brownish or greyish base, from which issues a thick purulent or copious watery secretion. The margins and base may be thickened by inflammation, but there are no granulations.

* Dr. West is, I believe, the only author who has hitherto pointed out the true cause of this difference.

† See case, p. 593.

Upon the question of the nature of this form of ulceration Foerster gives a useful hint. After describing a case which fell under his notice, and where he could find no traces of either encephaloid or epithelial cancer in the base of the ulcer, he mentions another which also to the naked eye appeared to have no cancerous basis, and yet on microscopic examination the entire base of the ulcer, to the depth of a line, was found to consist of cancer structure.* May not the thinness of this layer, by limiting the pabulum which feeds the progress of the ulcer, explain the slow advances of the latter observable in some cases of corroding ulcer?

Tubercle rarely effects the uterus, and still more rarely is it a primary disease of that organ.

Tubercle of the uterus exhibits the following peculiarities. The tuberculous deposit is limited in the first instance to the mucous membrane of the body of the organ. Here it occurs either in the form of tuberculous granulations, isolated or collected in groups, or more often as a uniform infiltration, limited at first to the mucous membrane, but ultimately penetrating more or less deeply the sublying uterine parenchyma, and accompanied by hypertrophy of the muscular coat. In the subsequent metamorphosis of the tubercular formation the infiltered membrane softens and melts down, so that the cavity becomes filled by a purulent pulpy fluid. The tubercular infiltration terminates abruptly at the inner uterine orifice†; or if rarely it penetrates the cervical canal or appears upon the vaginal portion, it is then only in the form of isolated tubercular granulations, which latter may probably pass into tubercular ulcers.

Tuberculosis of the uterus is usually associated with a corresponding condition of the mucous membrane lining the Fallopian tubes. These latter are found distended and their canals filled by caseous tuberculous matter.

Solutions of Continuity.

Laceration of the walls of the uterus occurs under various circumstances. It happens rarely in the unimpregnated organ, more frequently during pregnancy, and most commonly during labour.

Rupture of the walls of the unimpregnated uterus can only occur under abnormal conditions of the organ, as from considerable growths of fibroid, or from great distension of the cavity by watery, puriform, or sanguineous fluids, such as occur in hydro- and hæmatometra. See p. 697.

Rupture during pregnancy may happen at almost any period, but chiefly during the latter half, although it may take place even as early as the second month, as from vomiting.‡ Or it may be occasioned by violent spasmodic contraction, or from contusion or sudden concussion. It is most likely to happen in the case of the imperfectly developed uterus, as in the uterus unicornis, of which a description has been already given (p. 679.), or in the case of gestation in the uterine portion of the Fallopian tube (graviditas interstitialis, p. 621.).

Rupture of the uterus may occur upon only very slight exertion, as in the act of stooping*, or even without any obvious cause, as during sleep.† Most of the recorded cases, however, of spontaneous rupture of the uterus have occurred during labour, under violent uterine action, combined with some unusual resistance to the passage of the child, such as is occasioned by a distorted or fractured pelvis, a tumour, an unyielding state of the os and cervix uteri, or by some malposition or unusual bulk of the child. It may also occur from violence in instrumental delivery, or from injudicious efforts to turn the child.

The seat of rupture is most commonly the neighbourhood of the cervix, the laceration extending very often through the os to the vagina, or upwards, so as to involve more or less of the body of the uterus. It occurs oftenest at the sides, less frequently in the anterior or posterior walls, and least of all at the fundus.

The course of the laceration is generally oblique, rarely in the horizontal direction. It may, however, extend round the whole circumference of the cervix, the lower segment of the uterus being forced off in a single piece, before the presenting part of the child.‡

The length of the rupture may be such as to admit of the child escaping into the abdomen, among the intestines, or it may be only very slight. All the coats of the uterus are not necessarily involved. The peritoneum alone may be torn, numerous rents (40—60) occurring in this coat, without extending to the muscular tissue.§

These lacerations occur in most instances where the uterine tissues are perfectly healthy. In some cases the walls of the uterus have been apparently attenuated, the attenuation being attributed to pressure upon the spine or pelvic bones, or there has been more or less evidence of antecedent inflammation near the seat of the accident.

Perforation of the uterine walls occurs in cancer, (*fig.* 479.) followed by the establishment of fistulous communications with the bladder and rectum; or from penetrating abscess at the surface of the uterus; or as a consequence of adhesions formed between the uterus and an ovarian cyst, the contents of

* Handbuch der speciellen pathologischen Anatomie, 1854, p. 318.

† Boivin and Dugès' Atlas, pl. xvi.

‡ Case by Collineau. Journal Gén. de Méd. 1808.

* Mr. Glen's case in the eighth month of gestation, related by Dr. Merriman. Synopsis of Difficult Parturition, 1826, p. 268.

† Mr. Ilott's case, sixth month. Med. Repository, vol. vii.

‡ Mr. Scott's case. Medico-Chirurgical Transactions, 1821.

§ Trans. for the Improvement of Med. and Surg. Knowledge, vol. iii.

the latter being discharged through the uterine cavity.

Pathological conditions of the Uterus after Parturition.

Irregular contraction. — After tedious and exhausting labours, or those in which the uterus has been rapidly emptied, or under other circumstances which tend to the production of a general or partial atony of the organ, its post-partum contractions are often imperfect. The whole uterus may remain relaxed and undiminished in size, or a portion only of the walls may contract while the rest remain inactive. From the latter combination result the hour-glass and other irregular forms of the organ when the cavity of the uterus is partitioned into two chambers, in the upper of which a part or the whole of the placenta may be imprisoned. The seat of constriction being either near the fundus, or the centre of the uterus, or the neighbourhood of the cervix. This condition is often attended by hæmorrhage from the uncontracted portions of the uterine walls.

In explanation of these irregular contractions, it has been usually assumed that the contracted portions consist of the fibres that have retained their vigour, and the relaxed parts of those that have been exhausted. Numerous observations, however, have satisfied me that this is but an imperfect and, in some respects, an erroneous interpretation of this phenomenon. It appears to depend rather upon arrested peristaltic action, which may indeed be, and probably is, the result of exhaustion ; not, however, of a particular set of fibres, but of the ganglionic nerves which especially govern this movement of the organ. So that the peristaltic contraction in travelling along the uterus from os to fundus, is stopped in some part of its course. This explanation is consistent with the fact that these constrictions are not confined to any special region, but may occur at any point between the cervix and the fundus, and particularly with the circumstance that in some cases the constricted part may change its seat, the contraction being sometimes felt to travel onwards towards the fundus, while the hand is employed within the uterus in removing the placenta. See p. 673.

Rokitansky describes a remarkable result of partial contraction, with relaxation of the rest of the uterine fibre. When this occurs at the placental region, the part that gave attachment to the placenta being relaxed is forced into the cavity of the uterus by the superior tonicity of the surrounding tissues, and there constitutes a kind of tumour which, on account of its form and the protracted hæmorrhage that usually ensues, may be mistaken for a polypus or a hæmatoid growth.

Retarded and incomplete involution consists in an arrest of those metamorphic processes by which the uterus after parturition is restored to its ordinary condition. All inflammatory puerperal processes are attended by this condition in a greater or less degree. But involution may be arrested without inflammatory action, so that the uterus remains undiminished in bulk, its fibre uncontracted, and its tissues unrenovated for several weeks or months after labour. The soft flabby organ is easily distinguished above the pubes, reaching sometimes as high as the umbilicus ; while its cavity, tested by the uterine sound, may measure several inches in depth.

Puerperal inflammations.—The puerperal or post-partum inflammatory affections of the uterus may be noticed according as they involve the peritoneum, the proper tissue together with the blood-vessels and absorbents, or the lining membrane of the organ.

Puerperal endometritis.—Inflammation of the internal surface of the uterus occurs, as a primary affection of that organ, shortly (within a few hours or days) after labour. It takes the form usually of plastic inflammation, whose first seat is either the surface which has been exposed by the separation of the placenta, or certain portions that have suffered injury, such as lacerations and contusions, occurring during forced or spontaneous delivery. From these points, the inflammatory action may spread over the entire inner superficies of the organ, or it may involve more or less deeply the uterine parenchyma, and ultimately extend by contiguity to the peritoneum itself. The form of inflammation, and the nature of the exudative products, exhibit great variations in different instances, variations which are especially observable in respect of individual and epidemic influences, and are directly connected with corresponding conditions of the blood to be hereafter noticed. Endometrial inflammations have been accordingly distinguished by some pathologists, as croupy, dysenteric, catarrhal, and the like.

The exudations of the fibrinous or croupous kind, which are found upon the inner surface of the inflamed uterus, exhibit sometimes great plasticity. These may occur in the form of isolated patches, or of more extensive investments of a dense yellowish or greenish lymph, either firmly agglutinated to, or lying loosely upon, the sublying tissues. In inflammations of a less sthenic type, the exudation is softer and more gelatinous, and is often intermixed with serous and purulent fluids. Or the fibrinous matter may be wholly wanting ; the inflammatory products consisting then entirely of purulent discoloured and sanious exudations, which, in cases that have been distinguished as putrescence of the uterus, assume usually a greenish or dirty-brown coffee-coloured aspect.

The condition of the tissues, which are brought into view by removing or wiping away the above-mentioned products, exhibits corresponding variations. Beneath the coating of firm lymph, characteristic of uterine croup, the uterine tissue is merely softer and more spongy, and redder than usual; but in those forms of inflammatory action which rapidly pass into the puriform stage, the subjacent tissues become infiltrated and softened, so that they may be easily scraped away in the form

of a discoloured flocculent pulp. This condition, in its highest degree, where the tissues appear macerated and deeply penetrated by the dirty-coloured fluids already described, at the surface, constitutes uterine putrescence.

In addition to these products and results of inflammation, there may be found attached to the uterine surface fragments of an imperfectly detached placenta, or blood clots and shreds of the deciduous lining, lying free within its cavity. These, by their decomposition within the uterus, whose cavity, from the moment of parturition, has ceased to be completely closed against atmospheric contact, play an important part in the production of those septic and other infections of the blood which appear to form an essential part of all or nearly all puerperal inflammatory processes.

Puerperal metrophlebitis.—Inflammation of the veins of the uterus occurs most frequently in combination with, and is, to a certain extent, secondary to, the conditions last described; but it may occur also as a primary affection, and continue for a time the chief or only morbid state of the organ. The inflammation is seldom confined throughout to the veins of the uterus. It appears to commence in some of the orifices of the venous sinuses, which, after labour, terminate open mouthed upon the inner surface of the uterus, over the placental place, and thence spreading through those sinuses which occupy the uterine walls, it may extend to the spermatic and hypogastric veins and their tributaries, either upon one or both sides, and ultimately involve more distant vessels.

The condition of the veins in uterine phlebitis varies according to the intensity and duration of the inflammation. The inner coat may be pale or stained with the colouring matter of the blood. It may have lost its polish, or have become adherent to the contents of the vessel, where these are of a solid nature. The coats of the vessels affected may be thickened and opake, and the surrounding tissues infiltered by various colouring fluids, or softened and in a state of putrescence.

Regarding the contents of the vessels, these consist sometimes of firm plugs of fibrine coagulated from the blood, but more often of these in a softened grumous state, intermixed with portions of a yellow grey or whitish colour. The interior of such coagula may consist of a fluid not easily distinguishable from pus, but resulting from metamorphic changes in the fibrine, subsequent to its coagulation within the vessels. Or the veins may be distended by a brownish sanies, or a yellow or greenish yellow viscid pus, so that upon section of the uterine walls numerous collections of the latter, resembling separate abscesses, are displayed.

In the more severe cases of metrophlebitis the proper tissue of the uterus is deeply involved, being discoloured and in a state of disorganisation and putrescence throughout its entire thickness; or exhibiting at different points smaller or larger abscesses, the contents of which may have been discharged into the general cavity, or form ramified sinuses or fistulæ in the uterine substance. Such abscesses most probably arise from the suppurative inflammation extending beyond the coats of the veins, and involving the surrounding parenchyma.

Uterine phlebitis is often associated with inflammation of the uterine lymphatics (*Lymphangioitis*). These vessels, like the veins, become distended and varicose, and filled with a yellow or greenish puriform fluid, so that their course, together with that of the Fallopian tubes and ovaries, which are generally conjointly affected, may be easily traced into the corresponding hypogastric and lumbar lymphatic plexuses and glands.

Puerperal metro-peritonitis, or inflammation of the peritoneal coat of the uterus, is associated with either or both of the foregoing affections, or it occurs as the primary local disease, and sometimes constitutes throughout the sole apparent morbid condition of the uterus. The inflammation may be limited to the peritoneal covering of the uterus and its appendages, or it may involve that of the entire pelvic and abdominal regions. The membrane itself, which often exhibits little vascular congestion, may have retained its polish, or may be covered by exudative products of very various characters. These may be only small in amount, and partially distributed, or abundant and copious. They consist of firm fibrinous concretions, or softer and more pulpy yellow or greenish exudations, consisting of coagulable lymph loosened by serous or purulent infiltration, or thick purulent fluid, or semi-fluid matter, or lastly serous or sanious fluids, the latter being often discoloured and rendered turbid by intermixture with the before-mentioned products, especially with fibrinous flocculi and puriform and sanguineous effusions.

These several pathological conditions of the uterus, which appear to be incompatible with the progress of those normal changes in the condition of the organ that constitute the process of involution (see p. 658.), are accompanied almost invariably by a marked interference with those processes, so that the act of retrogression is either altogether arrested, or is in a high degree retarded.

The foregoing puerperal affections of the uterus exhibit numerous points of great pathological interest. These, even in their milder forms, cannot be generally regarded as purely topical affections, for they commonly, in their progress, become associated with like conditions of other and often distant organs, whose connection with the original, or at least principal, seat of disease, can only be explained upon the hypothesis of a general dyscrasis of the blood. It is probable that in some cases, of those, for example, whose commencement is apparently dependent upon miasmatic influences, inoculation with cadaveric matter and the like, a primary infection of the blood precedes the development of the

topical condition, which may be viewed as the local expression of the former. In a large number of instances, however, the affection of distant parts may be considered as the result of a secondary blood infection, *i. e.* of a poisoning of the blood by the introduction of some products from the original nidus of disease, and particularly of venous pus and sanies in metrophlebitis.*

The occurrences which immediately ensue upon the act of parturition, offer a ready explanation of the mode in which these and other extraneous matters may gain access to the general circulating fluid. For by the separation and removal of the placenta, together with a large portion of the decidua, the contents of the uterine cavity, consisting of various puerperal products now exposed to the direct influence of the atmosphere, are brought into immediate relation with the patent orifice of the uterine veins terminating upon the placental space. Through these a copious reception of the exudated products of inflammation or of septic matters resulting from decomposition within the uterus, or of infecting matter derived from sources still more external, may readily take place, and so produce either the primary or secondary dyscrases of the blood just noticed.

It is also to be observed that independent of external sources of a blood dyscrasis, the latter may be occasioned by an accumulation of effete material, resulting from the arrest of those eliminative processes which constitute so large and important a part of the act of involution, and are always more or less impeded during puerperal inflammation ; or commonly by a reflux of pus and sanies formed in the larger venous channels in the case of metrophlebitis already mentioned ; while some of the worst forms of sepsis of the blood are those which result from deep prostration of the nervous system, occasioned by exhausting forms of parturition.

The more important associated morbid processes occurring in connection with puerperal inflammation of the uterus, which it may be necessary here to notice, consist in exudations into the larger serous sacs and synovial bursæ, upon the mucous membranes, and in the parenchyma of various parts and organs ; and of deposits within the larger vessels, chiefly the veins leading from the uterus, or in the capillaries of organs often far removed from the original seat of inflammation.

The effusions upon the peritoneum and pleura, and less frequently upon the pericardium, consist of fibrinous and croupous exudations, combined often with copious effusions of serous, purulent, or sero-purulent fluids, the latter being, perhaps, often the result of a breaking down or liquefaction of the croupous fibrine, and its conversion into a pus-like fluid. Similar collections are found in the synovial membranes of the larger joints, especially of the knee, shoulder, and hip. While upon the mucous surfaces, particularly of the intestines, which are later affected than the serous structures, a less sthenic form of exudation is usually found, the effusion consisting here of serous, gelatinous, or purulent exudations (the former contributing largely to the production of puerperal diarrhœa), and of infiltrations into the mucous and submucous areolar tissues.

These various exudative processes, whose preference for particular tissues is probably in part determined by textural peculiarities, must be considered as efforts to eliminate the dyscrasial materials from the general blood mass, and they will continue until the exhaustion of the crasis is complete.

The qualitative variations observable in the products bear exact relation to the nature of the previous infection, and of the dyscrasis arising out of it. The character and mode also of the first effusions may materially affect those which occur at a later period ; for when the plastic products have been very abundantly and rapidly formed, and the defibrination of the blood consequently very considerable, the extensive discharge of the fibrinous element leaves the blood so attenuated, that the serous portion may then speedily transude through the walls of the capillary vessels, and in this way are produced those enormous collections of serous or sero-purulent fluids which sometimes rapidly form in the advanced stages of puerperal inflammations, occasionally with but slight evidences during life of their occurrence.

Of equal or greater interest are those associated pathological phenomena which are connected with secondary phlebitis, having its seat either in the larger veins, or in the capillary system of vessels. The veins nearest to the uterus are commonly first involved ; and from this point the inflammatory action may spread either by direct or interrupted continuity to more distant vessels, following, however, the reverse order of the circulation ; or it affects vessels remote from the original seat of inflammation, as in the capillary congestions, and inflammations of distant parts producing the lobular infarctions, and in more advanced inflammatory stages, the so-called metastatic abscesses and sloughs of various organs and tissues. The obstruction to the circulation arising in these cases from coagulation of fibrine within the vessels, and viewed by some pathologists as the cause, and by others as an effect only of inflammation, may be perhaps regarded as a provision for limiting the spread of the infecting fluids, and preventing, to a certain extent, their introduction into the general circulation.

In the larger vessels, especially in the veins nearest the point of primary infection, the fibrine is found under various conditions of coagulation, forming long cylindrical plugs, as in crural phlebitis, or shorter clots, whose red coloration depends upon the degree in which the blood corpuscles may have been incorporated in its several laminæ, or their paler yellow colour, upon the absence of the same, and the consequent greater purity of

* Rokitansky, *op. cit.* vol. ii.

the (perhaps effused) fibrine. The centre of these coagula may be found softened, and containing the creamy pus-like fluid which results from the molecular disintegration and liquefaction so commonly observed in fibrinous clots. Frequently the clots are of a less consistent texture, being of a dark brown or chocolate colour, or reduced to the consistence of a soft pulp. The coats of the veins may be thickened and adherent to the contained coagula, or covered by fibrinous laminæ or merely blood-stained, or presenting no deviation from the natural state.

LIGAMENTS OF THE UTERUS.

These terms are applied to several duplicatures of peritoneum, containing variable quantities of fibrous and muscular tissue, which serve to connect together the uterus and its appendages and to limit the motions of these parts within the pelvis. They are distinguished as the *broad*, the *round*, the *utero-sacral*, and the *utero-vesical* ligaments.

The broad ligament.— The fold of peritoneum in which the uterus is contained, after investing the fundus and anterior and posterior walls of the organ, passes off laterally in the form of a double lamina that extends from each uterine border horizontally outwards as far as the sides and base of the pelvis, to which it is attached. Thus a vertical septum is formed, which divides the cavity of the pelvis transversely into two chambers; the anterior and shallower one containing the bladder, the posterior and deeper holding the rectum and a portion of the small intestines. The uterus occupies the middle of the septum, while the lateral extensions of it form the *broad ligament* of either side. *Figs.* 368. and 404. *f*.

Attached to the upper border of the broad ligament are three folds, termed lesser wings. The central and superior of these, which is the largest, contains in its free falciform edge the Fallopian tube, and at its base a portion of the parovarium. It has been already described as the mesentery of the tube. The smaller posterior fold invests the ovary together with its proper ligament; while the third or anterior fold is inclined obliquely towards the body of the uterus, and constitutes the covering of the round ligament. Between the laminæ which form the principal or lower portion of the broad ligament, as well as within the alæ, are found the blood-vessels, lymphatics, and nerves which supply the uterus and its appendages, together with a variable amount of fibrous and unstriated muscular tissue that serves to connect the alminæ together.

This structure should be regarded as a mesentery rather than a ligament of the uterus. It serves to invest the uterus and its appendages with a common peritoneal covering, and to protect these parts and attach them to the pelvis, as the mesentery attaches the intestines to the spine; while the interspace of the folds suffices for the conveyance of vessels and nerves. The resemblance to a mesentery is more obvious in the bicorned and intestiniform uterus of the mammalia generally, as well as of many other vertebrata in which it forms the *mesometrium*.

The utero-sacral ligaments.— From the posterior wall of the uterine neck two falciform folds of peritoneum proceed towards the rectum. These are most easily seen when the parts are stretched. Between them lies the depression of variable depth known as the retro-uterine pouch, or space of Douglas. When the peritoneum is removed, these folds are seen to be occasioned by two corresponding bands of fibrous tissue, extending from the substance of the cervix backwards towards the sacrum, to which they are attached. Their strength varies considerably in different subjects; so that when not much developed they may be overlooked. The importance of these ligaments, or rather fibrous bands, has perhaps not been generally sufficiently appreciated. From their position and connections it cannot admit of doubt that they are intended to restrain the motions of the uterus, — to prevent it from being forced upwards in the act of conjunction, and especially to limit the descent of the organ in erect postures of the body.

The utero-vesical ligaments. — Opposite to the point of junction of the body and neck of the uterus, where the peritoneum is reflected forwards on to the bladder, are commonly observed two slighter lateral folds, containing bundles of fibrous tissue. These constitute the anterior or utero-vesical ligaments.

The round or sub-pubic ligament: ligamentum rotundum, ligamentum uteri teres. — This ligament consists of a flattened chord or band of muscular and fibrous tissue, which, traced from below upwards, proceeds from the internal inguinal ring in a curved direction towards the superior angle of the uterus on either side, where it is inserted in front of and a little below the commencement of the Fallopian tube. (*Figs.* 404. and 418.) The ligament of the right side is commonly shorter than that of the left: hence it happens that in pregnancy the uterus more often inclines to that side. According to Mr. Rainey*, the round ligament arises by three fasciculi of tendinous fibres: the inner one from the tendons of the internal oblique and transversalis muscles near the symphysis pubis; the middle one, from the superior column of the external abdominal ring, near its upper part; and the external fasciculus, from the inferior column of the ring, just above Gimbernat's ligament. From these attachments the fibres pass backwards and outwards, soon becoming fleshy: they then unite into a rounded chord, which crosses in front of the epigastric artery, and behind the lower border of the internal oblique and transversalis muscles, from which it is separated by a thin layer of fascia continuous with the fascia transversalis: it then gets between the layers of peritoneum forming the broad ligament, along which it passes backwards, downwards, and inwards to the point of insertion already described.

* On the Structure and Use of the Ligamentum Rotundum Uteri, Phil. Trans. p. 515. pt. ii. 1850.

The round ligament is composed of smooth muscular fibre, derived from the uterus, and arranged in bundles, surrounded by connective tissue, of striated muscle, continuous with that of the abdominal parietes, and of blood-vessels, lymphatics and nerves.

The peritoneal covering of the round ligament is occasionally prolonged in young subjects at its lower part through a portion of the inguinal canal, where it forms the *canal of Nuck*. This is usually obliterated in adults, where the arrangement of the *tendinous part* of the round ligament just described serves to close the internal ring, and to prevent, in a great measure, the occurrence of inguinal hernia in the female. The persistence of this canal probably leads to the abnormal descent of the ovary into the labium, constituting hernia of the ovary (see p. 574.);—an occurrence exactly comparable with the normal descent of the testis into the scrotum of the male.

VAGINA.

Normal Anatomy.

Syn. Vulvo-uterine canal.—The vagina constitutes a flattened cylindroid, extending from the vulvar orifice to the neck of the uterus. It lies entirely within the pelvis, between the bladder and rectum, running very nearly in the direction of the axis of the pelvic outlet, but having a slight curvature forwards. The orifice of the vagina is bounded anteriorly by the vestibule, laterally by the nymphæ, and posteriorly by the hymen. The upper or blind extremity, termed the fornix, receives the vaginal portion of the uterine neck, which is not placed exactly at the termination of the canal, but appears as if it were let into its upper wall (*fig.* 433.).

Dimensions.—The vagina is capable of considerable extension. It varies in dimensions in different subjects. In the ordinary virgin state, the anterior wall, which is the shorter, measures, from the median tubercle of the vagina to the anterior lip of the uterus, less than two and a half inches; and the posterior wall, from the centre of the vulvar orifice to the end of the fornix, three inches. The transverse diameter, in the natural state of the canal, which is flattened from before backwards, so that the anterior and posterior walls are in contact, measures ordinarily one inch and a quarter. But when the canal is distended, and after the birth of many children, these dimensions may be much exceeded.

External surface.—The following are the relations of the external surface of the vagina. *Anteriorly*, it is connected to the urethra and base of the bladder by areolar tissue. *Laterally*, it is in relation with the root of the broad ligament and the pelvic fascia. *Posteriorly*, in the first part of its course, it is covered by the peritoneum, forming the anterior wall of the retro-uterine pouch, or space of Douglas; secondly, where the peritoneum ceases, and for about half its course, it is united to the rectum; and lastly, it is separated from the latter by the thickness of the perineum.

Composition.—The walls of the vagina are of variable thickness in different parts, the average being 1‴. They are composed of three coats. The outermost of these is formed of fibrous tissue, intermixed with an abundance of elastic fibre. Beneath this is a second or muscular coat, containing unstriped muscular fibre and fibre-cells, which, during pregnancy, undergo a development similar to that of the uterine fibre. The third, or innermost, is the mucous coat, composed of a dense connective tissue, with much admixture of elastic fibre, to which is due a great part of that elasticity and distensibility with which the vagina is endowed. Imbedded in the substance of the mucous membrane, which is covered by squamous epithelium, are numerous muciparous follicles.

Internal surface.—Upon the inner surface of the canal the mucous membrane is thrown into folds, which, in the virgin, form numerous closely-set transverse rugæ, that are arranged with a certain approach to regularity, and sometimes exhibit a central connecting line or raphé, forming the *columnæ rugarum*, upon the anterior and posterior walls. At the sides of the vagina these folds are less prominent, and take an oblique or longitudinal direction. In some subjects the rugæ are covered by, or are chiefly composed of, short, crowded verrucose papillæ, intermixed with others more filiform. They become larger towards the vaginal orifice, where they sometimes take the form of little leaflets, resembling the smaller fimbriæ of the Fallopian tube, especially about the meatus urinarius. After numerous acts of parturition, as well as from frequent intercourse, the folds become obliterated, and the inner surface of the vagina is rendered nearly or entirely smooth.

Arteries.—A special artery usually exists for the vagina, which may arise either from the hypogastric, internal pudic, middle hæmorrhoidal, or even from the obturator. From one of these origins the artery descends along each side of the vagina, giving off in its course numerous branches, which inosculate in the recto-vaginal septum with those of the opposite side. Near its extremity, the artery sends off a considerable branch to the bulb of the vagina, and after supplying the external organs, it terminates by inosculating with the artery of the opposite side, between the vagina and rectum. One or two separate branches are generally found to arise from the uterine artery. These descend between the bladder and the vagina, supplying branches to both those parts. An abundant and intricate network is formed in the vaginal walls by the ramifications of the smaller vessels derived from these sources, which interpenetrate the several coats down to the mucous membrane.

Veins.—The veins which collect the blood from the labia, constrictor muscles, and mucous membrane of the vagina, and from the erectile tissue forming the vaginal bulb, unite to form a considerable plexus, especially around the vulvar orifice termed the vaginal plexus. From this plexus branches pass to

the vesical, and hæmorrhoidal, and uterine plexuses ; the blood being finally collected by large veins which empty themselves into the internal iliacs. *Figs.* 482. and 483.

The *Lympatics* are those which are common to the bladder, cervix uteri, and lower part of the rectum. They terminate in the pelvic glands.

The *Nerves* are derived from the pelvic plexus, which contains a large proportion of tubular fibres, derived from the fourth and fifth sacral nerves.

Uses of the vagina. — The vagina, during copulation, serves for the reception of the male intromittent organ, and for the lodgement of the seminal fluid in such a position as to facilitate the introduction of that fluid into the uterus.* During menstruation the vagina gives passage to the catamenia. In labour it transmits the fœtus and secundines, and subsequently the lochia.

Abnormal Anatomy of the Vagina.

Anomalies. — Congenital absence of the vagina is not very rare. The entire vagina may be wanting ; so that on separating the labia no trace appears of a canal leading to the uterus ; or the canal may be so narrow as only to admit a probe or quill ; it may be very short, terminating in a *cul de sac*, or it may open into the urethra or rectum. The latter malformation has not always prevented pregnancy, even when combined with an entire absence of the external organs.

A vertical septum occasionally divides the vagina through a greater or less portion of its course. This, when complete, produces the double vagina with double hymen (*fig.* 461.). The septum may cease at a variable distance from the vaginal orifice, the fornix and upper part remaining single ; or, contrarily, the fornix may show signs of division, while the lower part of the tube remains single. The septum is almost invariably in the median line, but the more frequent use of one or other channel in parturition or sexual conjunction may give to them an appearance of unequal development.

Transverse membranous septa sometimes pass across and obstruct the vagina more or less completely. These, though they do not necessarily prevent impregnation, for they are seldom absolutely imperforate, may so far impede labour as to require division. They occur at various points within the canal ; at a short distance from the orifice, or as high up as the level of the utero-sacral ligaments. They consist, for the most part, of natural folds unusually developed, or they result from accident, as inflammation or injury consequent on difficult labours. Some of those constrictions which occur near the orifice are doubtless the consequence of inflammation of the vulva and vagina in infancy.† Atresia of the vagina may thus be acquired, or it may be congenital. When the obstruction is complete, retention of the menstrual fluid results.

Displacements. — The vagina may be altogether displaced from the pelvis, or it may simply have its normal direction altered within that cavity. Prolapsus of the vagina occurs sometimes alone, but it is more often combined with procidentia or inversion of the uterus (*fig.* 469.). In any of these cases, if the prolapse is permanent, the vaginal surface loses altogether the character and appearance of a mucous membrane, acquiring a thick cuticular covering, and assuming the condition of ordinary integument. In retroversion of the uterus, the vagina is drawn upwards and forwards, its extremity lying behind the pubic symphysis. (*Fig.* 468.) In hernia of the uterus, the vagina is diverted from the median line towards one or other side of the pelvis, and may be partly included in the hernial sac.

Solutions of continuity. — Laceration of the vaginal walls may occur during obstructed labour, and is then frequently associated with rupture of the uterine cervix. Fistulous openings into the bladder, and sometimes into the rectum, are occasioned by sloughs consequent on protracted labour. Fistulous cloacæ are also commonly formed in advanced stages of cancer (*fig.* 479.).

Inflammation of the vagina. — *Vaginitis.* — This occurs both in the acute and chronic form. It may present the character of benignant catarrh, or of a specific blenorrhœa (*gonorrhœa*). In the more acute form the mucous membrane is highly vascular, and is sometimes excoriated, from excessive shedding of epithelium. The discharge presents variable characters, from the viscid yellow puriform mucus, to the creamy, milk-like, or thin, nearly watery, fluid (*leucorrhœa*).

Croupous exudations occasionally form upon the vaginal mucous membrane, chiefly in connexion with typhoid exanthematous or puerperal processes.

Epithelial desquamation. — Occasionally the entire epithelial coat of the vagina is thrown off, forming a membranous cast of that canal. Several of these casts may be found, one contained within another. Their discharge may be accompanied by symptoms resembling those of dysmenorrhœa ; but more particularly by an intolerable itching or sensation of crawling in the vagina. They are composed entirely of dense vaginal tessellated epithelium.*

Serous and sanguineous infiltration into the mucous and fibrous coats of the vagina takes place occasionally during protracted labour, producing considerable tumefaction, and consequent narrowing of the canal. In this state

* See Insemination, p. 671.

† These cases are sometimes recorded as examples of imperforate hymen.

* I have given a description, with several illustrative figures, of these epithelial casts of the vagina, some of which include also the epithelium of the vaginal portion of the cervix uteri, in Beale's Archives of Medicine, for April, 1858. I suspect that the nature of these has been overlooked, and that they have been confounded with the true dysmenorrhœal membranes which consist of the lining membrane of the uterus. See *fig.* 443.

the vaginal walls are easily lacerable, or if subjected to continued pressure pass readily into gangrene.

Abscess forms occasionally in the vaginal walls, but many of the abscesses which burst into that canal have their origin in pelvic cellulitis, or in inflammation of other structures external to the vagina.

Ulceration. — The minute aphthous ulcers which are dotted over the surface of the vagina originate in follicular inflammation. The more extensive and irregular ulcers, except those which form upon the more exposed parts when the vagina is inverted, as in procidentia uteri, are usually either syphilitic or cancerous.

Gangrene of the vagina occurs in conjunction with gangrene of the vulva in septic puerperal processes ; or it results from pressure in protracted labour. Spontaneous gangrene occurs also occasionally in infants and young children.

Cysts and tumours. — The former, if of small size, may result from obstructed mucous follicles ; but more often the larger cysts arise in situations external to the vagina, and protrude into its canal. In the same way, fibrous or osseous tumours growing from the periosteum or ligaments of the pelvis, ovarian, or even uterine tumours may, by pushing before them the walls of the vagina, protrude into the canal. Vaginal cystocele and rectocele occur in a similar manner. The tumours which lie free within the vagina are chiefly uterine polypi, or cancerous tumours of the cervix or of the vagina itself. The uterus, when partly inverted, also forms a tumour occupying the vagina.

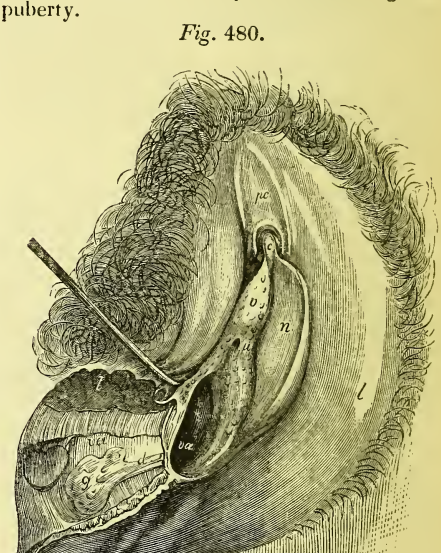
Cancer may originate in the vagina, although it more often constitutes an extension of the same disease from the uterus. In either case it appears most commonly as medullary cancer, taking the form of tuberculated masses or ridges, which narrow or obstruct the passage, and quickly pass through the stages that characterise the ordinary progress of uterine cancer. The surrounding parts become infiltrated with cancer matter, and the vagina is fixed in the pelvis, ulceration of the walls and fistulæ resulting. Occasionally, at the commencement, this disease appears in the form of soft, rapidly-growing papillary structures, springing from the upper and posterior wall of the vagina (*villous cancer*).

EXTERNAL ORGANS OF GENERATION.

Syn. *Vulva. Pudendum.* — These parts perform subordinate offices in the act of reproduction. They are in no way concerned in gestation, and only slightly in menstruation and parturition. They are associated with the vagina in the act of copulation, which has for its object insemination, or the conveyance of the seminal fluid to the internal or formative organs. The parts which serve to establish this relation between the sexes, with the exception of the vagina, are placed external to the body, and are attached to the front of the pelvis. They are included under the general term *vulva* or *pudendum*, which extends from the mons veneris to the perineum. The vulva consists of the following parts, viz. labia, clitoris, nymphæ, vestibule, vaginal orifice, and hymen.

The Mons Veneris forms a slightly rounded or flattened eminence, of triangular outline, covering the symphysis and horizontal rami of the pubes. In fat subjects it is separated from the abdomen by a transverse furrow. It is composed of adipose and fibrous tissue, covered by integument. The latter contains many sebaceous and hair follicles. The hair is not developed until the age of puberty.

Fig. 480.



External organs of generation, and commencement of vagina. (After Huguier.)

l, labium of left side (that of the right side is divided and partly removed to expose the vagina and vulvo-vaginal gland); *n*, nympha; *c*, glans clitoridis; *p c*, preputium clitoridis; *v*, vestibule; *u*, orifice of urethra; *v a*, vagina; *g*, vulvo-vaginal gland, or gland of Bartholin and Duvernay; *d*, duct of the same.

The Labia, termed also *labia majora*, to distinguish them from the lesser labia or nymphæ, are two symmetrical tegumental folds (*fig.* 480. *ll*), placed one on either side of the *rima* or fissure which leads to the vagina. The labia vary considerably in size and form in different subjects. In stout adults they are full and fleshy, closing the vulvar orifice, and concealing the rest of the generative organs, which they serve to protect. In the aged the labia become shrivelled and the nymphæ protrude between them, as they also commonly do in infants and young subjects. The outer surface of each labium is composed of common integument, which at the age of puberty

becomes covered with hair. Along the line of apposition of the two labia, where the rima is formed, the hair and integument cease, and the mucous membrane common to the rest of the generative canal commences. From this point inwards the surface of the labium is smooth, of a reddish or pink colour, and is here furnished with numerous muciparous and sebaceous follicles, which bedew the parts with an odorous secretion, and preserve their constant moisture. The labia are united above by a slight frenulum, termed the *anterior commissure*, while below they are connected, at the anterior margin of the perineum, by a broader *posterior commissure*. When the parts are here drawn asunder, a second fold appears within the former, just below the entrance of the vagina. The transverse boat-shaped furrow between these constitutes the *fossa navicularis*. Beneath the cutaneous and mucous covering of the labia is found a layer of *dartoid* tissue, the rest of their substance being formed of loose *fibrous and adipose* tissue.

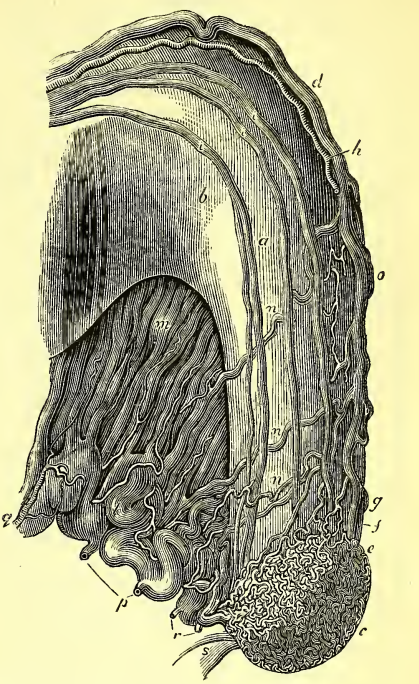
The labia represent the scrotum, which in the early fœtus is divided into two halves. A raphé indicates in the male the line of their subsequent confluence. In the female the two halves remain permanently separate. The normal descent of the testis into the scrotum in the male, about the seventh month of intra-uterine life, is represented by the abnormal descent of the ovary into the labia of the female which constitutes ovarian inguinal hernia. (See p. 574.)

When the labia are drawn asunder, the clitoris, the vestibule, nymphæ, and vaginal orifice are brought into view.

The Clitoris (*figs.* 481. and 482.), in general form and composition, resembles, on a diminutive scale, the penis, but it is deficient in some of the parts which compose the latter organ. The clitoris lies in the upper part of the vulvar fissure, concealed between the labia, and encased in a fold of mucous membrane, the lower border of which forms a hood or prepuce (*preputium clitoridis*) (*fig.* 480. *p c*), that terminates just above the superior commissure of the nymphæ, and allows the extremity only of the organ to appear. When this covering is removed, the clitoris is seen to consist of the following parts: viz. a small imperforate *glans* (*fig.* 481. *c*), composed of spongy erectile tissue, and covered by a highly sensitive mucous membrane, which is abundantly supplied with nerves; this terminates the free extremity of the organ: a *body* (*fig.* 481. *b*), consisting of two *corpora cavernosa*, united along the median line, and invested by a fibrous tunic. The body extends upwards and backwards to a point a little above the centre of the pubic arch. Here it makes a sudden downward curve, and, after dividing into two *crura*, is attached by these beneath the iscio-pubic rami of either side. Opposite the point of curvature, a flattened *suspensory ligament* attaches the body of the clitoris to the pubic symphysis. Two ischio-cavernous muscles (*erectores clitorides*), composed of striped muscular fibre, are inserted into the crura. They have the same relations, and, according to Kobelt, are fully as long as in the male (*fig.* 483. *n*).

Blood-vessels.—Two *dorsal arteries* (*fig.* 481. *h*), running along the upper surface of the

Fig. 481.



The clitoris (*enlarged* 4 *diameters.*) (*After Kobelt.*)

a, body; *b*, angle or curvature; *c*, glans; *d*, vena dorsalis; *e*, superficial veins emerging from the root of the glans, and *f g*, veins of deeper origin. These transmit the blood to the vena dorsalis; *h*, dorsal artery; *iii*, dorsal nerves; *k*, the venous plexus, termed pars intermedia (shown also at *d*, *fig.* 482., and *e*, *fig.* 483.); *l*, communicating venous branch between the glans clitoridis and pars intermedia; *m*, ascending venous canals proceeding from the pars intermedia (*k*) to the under surface of the body of the clitoris; *n n* and *o*, lateral branches of communication between the vessels last named and the vena dorsalis; *p*, veins from the labia, and *r*, from the nymphæ and frenulum clitoridis, which enter the pars intermedia; *q*, arterial branches corresponding with the pars intermedia and communicating veins; *s*, frenulum clitoridis.

clitoris, supply the glans, from which the blood is again collected by superficial veins, emerging from the root of the glans at *e*, and by others having a deeper origin at *f*. These transmit the blood to the *vena dorsalis*, *d*. From the cavernous bodies the blood is also collected by a series of vascular canals, of which an account will be presently given.

Nerves.—The clitoris is richly endowed with *nerves*, *i i*, which are *relatively* three or four times larger than those of the penis. They pass along the sides of the clitoris, each dividing usually into three branches, the ultimate ramifications of which lose themselves

partly in intricate plexuses within the glans, and partly in terminal loops upon its mucous covering.

Development. — In the fœtus of three to four months, the clitoris is scarcely distinguishable from the penis. But about the latter period the proportionate retrocession of the one organ, and the increased development of the other begin to be apparent. In the male, the groove along the under surface of the penis is closed in, and at the same time the raphe of the scrotum is formed; while in the female, the parts corresponding with the bulb and corpus spongiosum urethræ remain open, and constitute a portion of the rima. These lie in two halves on either side of the entrance of the vagina, while the urethra is developed independently of them.

Nymphæ.—*Labia minora v. interna.*—These consist of two thin and slightly fleshy folds of mucous membrane (*fig.* 480. *n*), somewhat resembling a cock's comb, which lie on either side of the entrance to the vagina, extending from the clitoris downwards, as far as the middle or lower border of that orifice. The nymphæ commence above by two roots. The inner one, thin and membranous, is inserted beneath the glans clitoridis, and forms with its fellow a kind of *frenum*. The outer one, more fleshy, passes round the glans, and by its junction with the corresponding portion of the opposite side constitutes the *preputium clitoridis* (*fig.* 480. *p c*) already described. From these two roots or origins each nympha extends downwards and outwards, forming a thin prominence, of variable extent in different subjects, until it becomes merged in the labium of the corresponding side, near its posterior extremity.

The nymphæ are composed almost entirely of mucous membrane, which on their outer side is continuous with that of the labia, and upon their inner surface with the lining membrane of the vagina.

Various uses have been assigned to the nymphæ. One of these is that they serve to direct the stream of urine issuing from the urethral orifice, as suggested in the classic allusion to the sea nymphs pouring water from a vase which is implied in their name. Another supposition is that the nymphæ aid the enlargement of the vaginal orifice, by becoming unfolded at the time of labour, although no such unfolding can be absolutely observed. It is more probable that their office is that of extending the secreting and sensitive surfaces at the entrance of the vagina.

The nymphæ correspond with that part in the male which forms the tegumental covering of the urethra, but which remains ununited in the female along the median line.

The Vestibule. — This term has been employed in two senses. In its widest sense it includes all the parts which immediately surround the vaginal orifice. In a more restricted meaning, it is limited to that triangular patch of mucous membrane (*fig.* 480. *v*) which fills up the summit of the pubic arch. In the latter sense the apex of this triangle is formed by the clitoris, the sides by the upper halves of the nymphæ, and the base by the roof of the vaginal orifice. In the centre of the base is situated the *meatus urinarius*, which forms here a slight prominence (*fig.* 480. *u*), at a distance of one inch behind the clitoris. Immediately below this point the anterior column of the vagina terminates in a prominent bulb or tubercle, marked usually by numerous transverse folds.

Orifice of the Vagina, and Hymen.— Immediately below the vestibule, and between the nymphæ, is the orifice of the vagina (*fig.* 480. *v a*), which, in its undistended state, has the form of a vertical fissure, especially in women who have borne children, but in virgins it is more constricted and circular, and is further narrowed by a fold of the vaginal mucous membrane, the *hymen*, which either encircles or semi-encircles the orifice. As some important questions in obstetric and forensic medicine relate to this membrane it will receive here a more particular examination.

The hymen, regarded in an anatomical point of view, possesses no peculiarity or speciality by which it is essentially distinguished from many like structures in other parts. It belongs to the same class of formations as the valvulæ conniventes of the intestines, and the frill-like folds of mucous membrane which not infrequently surround the terminal orifices of mucous tubes. In the fœtus such folds are seen with various degrees of distinctness at the termination of the urethra, vagina, and often of the rectum. The lower end of the vagina, in the fœtus *invariably* terminates in a marked projection outwards of the mucous lining of the tube. It takes the form of a laterally compressed conical fold, the base of which is continuous all round with the vaginal walls, but the apex is directed forwards. Its centre exhibits a vertical slit-like orifice, the direction of which is apparently due to the lateral compression of the nymphæ and labia, between which it lies. This is the hymen. In advanced fœtuses it is scarcely distinguishable in form, and only to a certain extent in size, from the similar conical termination of the cervix uteri, which projects into the vagina, as the hymen does between the nymphæ. The vaginal portion of the cervix uteri and the hymen both constitute invaginations or intussusceptions at two different points of the same mucous tube, —the one marking the division between the uterus and the vagina, the other between the latter and the external parts. The chief difference between them is that the direction of the orifice in the former is transverse, and in the latter vertical.

Such is the condition of the hymen during fœtal and infantile life. But as growth advances the posterior half becomes much more developed than the anterior, just as the posterior half of the uterus, the posterior lip of the cervix, and the posterior wall of the vagina, are commonly larger and more developed than the corresponding anterior halves. Thus it happens that in adults the hymen presents usually the form of a crescentic or semilunar fold, the concave border of which

is directed upwards or forwards, while that which had been in the fœtus, the upper half, has now become unfolded or lost among the plaits of mucous membrane, situated at the upper part of the vaginal entrance. This, because it is the most constant, has been usually regarded as the typical form of the hymen. But the fœtal form is also often retained, namely, the circular fold of mucous membrane, which, as the parts become more expanded, acquires a round rather than a slit-like aperture. If, however, the folds of the mucous membrane lining the vagina are profusely developed, then the hymen also exhibits the form not so much of a distinct membrane as of an irregularly constricted orifice, the sides of which are puckered or gathered into plaits, so as nearly to close the vaginal entrance. And this also is a very common condition of the part, especially in young subjects.

The varieties, therefore, in the hymen which anatomists recognise, such as the crescentic, circular, cribriform, and the like, become easily explicable. They all proceed apparently from a common starting point, but differences in the degree of development, or accident, may determine the permanent form. The *half-circle* and *crescent* result from a normal development of the posterior, and a corresponding retrocession of the anterior, moiety of that conically projecting mucous fold which is more or less distinct in every fœtus. The hymen with a *central* or nearly central circular orifice, results from a flattening down and retiring within the vaginal orifice of the cone; the retiring naturally following upon an expansion of the vaginal walls as growth advances. The appearance of a *notched margin* to the central aperture is produced by the prominent edges of the terminal vaginal folds, which are in some subjects more profusely developed than in others. The *cribriform* hymen probably results from an abnormal cohesion of these notched edges, in such a manner, that small apertures are left between them, and the completely *imperforate* hymen by an entire adhesion of the margins of the orifice, the result sometimes of inflammation in infancy.

The hymen, however various its forms may be, consists of a double layer of mucous membrane, containing between its laminæ a small quantity of fibrous tissue and blood-vessels. It is of variable degrees of thickness, being in some subjects very strong and tough, and in others forming a very slender lamina. Its situation is at the entrance of the vagina. Although the depth at which it is placed within the vulva varies in different subjects, according to the thickness of the labia, and the size of the nymphæ and vestibule. Occasionally, as already stated, one or more plicæ of the vaginal mucous membrane, more than usually developed, form constrictions at a higher point within the canal, but the term hymen cannot with propriety be applied to any of these.

The presence of the hymen, although it raises a strong probability of virginity, yet affords no certain evidence upon that point, nor does its absence establish the contrary.

The hymen is commonly said to be ruptured on the occasion of a first complete intercourse, but the expression unfolded would probably, in many instances, more accurately represent the mode of its disappearance. Whenever the hymen presents any considerable membranous surface, doubtless a real laceration occurs, but in the cases in which it takes the form of a crescentic fold, or of a puckered rosette, instead of being lacerated, it probably becomes unfolded or flattened out, and so disappears, just as the ordinary vaginal folds are obliterated, by frequent intercourse or by parturition, without any rupture.

Upon the presumption that the hymen is always *lacerated* a certain hypothesis has been raised, namely, that the little fleshy bodies occasionally observed near the orifice of the vagina, termed *carunculæ myrtiformes*, constitute the remains of that membrane. But, notwithstanding a great amount of evidence that has been collected regarding the myrtiform bodies, it cannot be shown that these are anything more than accidental and uncertain formations, having nothing necessarily to do with the hymen.

The hymen may be broken by accident, or may become obliterated by the frequent employment of vaginal injections, and in other like modes. Or, from constant leucorrhœa, the parts may become so relaxed that a distinct membranous fold can be no longer discerned at the vaginal orifice, although there may have been no loss of virginity.

On the other hand, impregnation may take place without destruction of the hymen, which has frequently been found entire at the time of labour, and even in women affected by syphilis.*

Sebaceous and Muciparous Glands and Follicles of the Vulva. — The *sebaceous* follicles correspond with the male preputial follicles. They are scattered over the nymphæ, clitoris, and inner surface of the labia. Their secretion contains butyric acid and has a strong and somewhat ammoniacal odour. This occasionally becomes highly irritating, especially when cleanliness is neglected.

The *muciparous* follicles are arranged in groups, the principal ones being situated upon the vestibule (*vestibular follicles*, *fig.* 480. *v*), around and upon the sides of the meatus urinareus (*urethral follicles*, *fig.* 480. *u*), and at the sides of the entrance of the vagina (*lateral follicles of the vaginal orifice*, *fig.* 480. *va*).

The muciparous follicles are composed of a delicate vascular mucous membrane arranged in the form of short mucous crypts, or consist of simple or branched tubules ending

* In a case of extensive syphilitic periostitis which came under my notice, in a woman thirty years of age, who had previously been a prostitute, a tough membranous circular hymen closed the orifice of the vagina so completely that the tip of the fore finger could scarcely be inserted within it.

in a *cul-de-sac*. The vestibular follicles are of the former kind and the urethral of the latter.

All these vulvar follicles secrete a viscid mucus, the quantity of which becomes considerably increased under excitement or irritation. It serves to lubricate the several parts of the vulva.

The *vulvo-vaginal glands*, termed also the glands of Bartholin and of Duvernay, consist of two conglomerate glands of the size of a haricot bean, variable in form, and of a pale reddish yellow colour, which are placed one upon each side of the vagina near the entrance (*fig.* 480. *g*). They are lodged beneath the superficial perineal fascia, having their inner side united to the vagina by areolar tissue, and their outer surface in relation with the constrictor muscle of the vagina. The lobules composing this gland send off tubules which at its upper and fore part unite to form an excretory duct that proceeds horizontally forwards as far as the vaginal orifice, upon the side of which it terminates just within the nymphæ and externally to the hymen. The orifice of the duct (*d*) is covered by a falciform fold of mucous membrane, which renders its discovery sometimes difficult.

This gland secretes a viscid fluid resembling somewhat the prostatic fluid and having a peculiar odour. Under excitement its secretion is rapidly formed and, like the contents of the salivary duct, is sometimes emitted in a jet. This gland is probably homologous with Cowper's gland in the male. In infancy and early life it is very small, attaining its full development in the adult, and again diminishing and even disappearing in old age.

When the labia and nymphæ are abscised a series of vascular erectile structures are brought into view, which, together with a special muscle, surround the vaginal orifice. These are the *vestibular bulb*, *pars intermedia*, and *constrictor vaginæ muscle*.

Pars intermedia.—From the dorsal vein of the clitoris (*fig.* 481. *d*) several branches (*n*,*n*) pass downwards round the sides of the organ to communicate with a double row of closely-set venous canals, which commencing anteriorly at the glans extend backwards to the root of the clitoris in the form of a frill that completely occupies the angle contained in the curvature of the organ (*fig.* 481. *m* and *fig.* 482. *f*). These venous canals enter the body of the clitoris by a double row of apertures along its under surface. They represent the communicating veins between the corpus spongiosum urethræ and the corpora cavernosa penis. After receiving branches from the glans clitoridis (*fig.* 481. *l*), nymphæ (*r*), and labia (*p*), they form on either side a series of convoluted veins (*k*), which spreading downwards and outwards ultimately terminate below in the bulb of the vestibule (*fig.* 482. and 483. *a*). This is the structure termed by Kobelt the *pars intermedia*. It corresponds with the corpus spongiosum urethræ of the male, which in the female remains divided into two halves. The arteries of this structure (*fig.* 481. *q*) are derived from the pudendal.

Fig. 482.

Lateral view of the forepart of the pelvis, attached to which are the clitoris and the vascular and erectile structures connected with it. (*After Kobelt.*)

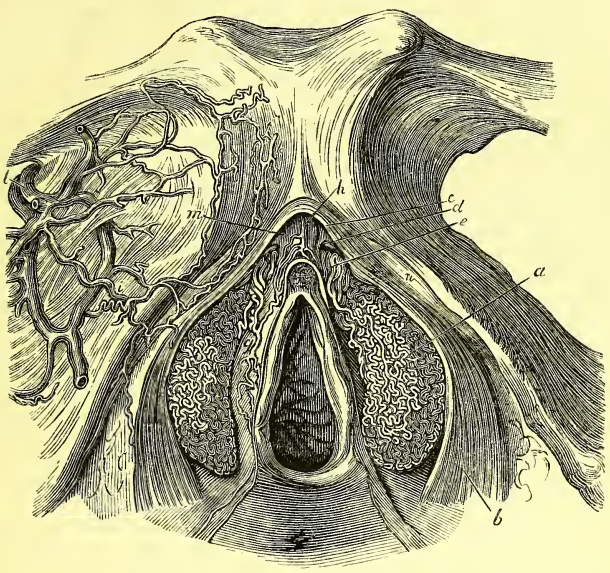
a, vestibular bulb of the left side; *b*, veins passing off from the lower and posterior border of the bulb, to the pudendal vein; *c*, similar veins communicating with the hæmorrhoidal; *c'*, the spot at which the veins of the vestibular bulb pass off to the vagina; *d*, pars intermedia; *e*, glans clitoridis; *f*, ascending communicating veins proceeding to the body of the clitoris; *g* and *i*, lateral communicating branches between the vena dorsalis clitoridis and pars intermedia; *h*, vena dorsalis; *k*, bend of the clitoris; *l*, crus clitoridis; *n*, vulvo-vaginal gland.

Bulbus vestibuli (Kobelt). *Plexus retiformis v. reticularis* (De Graaf). *Crura clitoridis interna* (Swammerdam). *Plexus cavernosus* (Tabarranus). *Corpus cavernosum* (Santorini). *Semibulb* (Taylor). *Bulb of the vagina.*—Lying one on either side of the entrance to the vagina, and behind the nymphæ and labia, are two masses of vascular parenchyma, composed almost entirely of tortuous veins enclosed in a fibrous membrane. These in their collapsed state are of the size and form of an almond; but when injected may be compared to a filled leech (*fig.* 482. and 483. *a*). Anteriorly they are directly continuous with the structures last described, while from their sides communicating branches pass back to the obturator veins (*fig.* 483. *l*), and from their lower ends to the pudendal and hæmorrhoidal veins (*fig.* 482. *b* and *c*). The bulb of the vagina, now commonly regarded as the homotype of the bulb of the urethra which is here bipartite, forms the principal portion of the erectile tissue surrounding the vaginal orifice.

Constrictor vaginæ.—The clitoris together with its bipartite pars intermedia and vestibular bulb is encased in a thin sheet of mus-

cular structure (*fig.* 483. *b* and *c*), which has been usually regarded as the constrictor of the vaginal orifice, but which Kobelt considers to be more particularly employed as a compressor of the parts just named. This muscle takes its origin in a broad flattened base (*b*) from the perineal fascia midway between the anus and tuber ischii. The inner fibres interlace with those of the sphincter ani, while the outer ones reach to the corresponding ascending ischial ramus. Thence the muscle becomes gradually smaller as it ascends, and after embracing the entire length and breadth of the vestibular bulb, it converges forwards to meet its fellow at the clitoris, where it terminates in two little flattened portions of which the posterior passes as a narrow tendon (*fig.* 483. *d*) to unite with its fellow between the upper end of the bulb and the root of the clitoris, while the anterior looser portion (*c*) mounts over the dorsum of the clitoris, forming the *musculus attrahens clitoridis*. This serves to depress the organ and compress the dorsal vein, at the same time that the lower portion of the same muscle, by compressing the rest of the vascular apparatus, forces the blood out of the vestibular bulb and pars intermedia upwards into the body of the clitoris, and thus aids in producing congestion and erection of all these parts during coition.

Fig. 483.



Anterior view of the parts represented in Fig. 482. (*After Kobelt.*)

a, vestibular bulb; *b*, constrictor vaginæ muscle, according to Kobelt the compressor of the bulb. It is here represented as drawn back behind the bulb, which in the natural position is covered by it. *c*, anterior division of the muscle which passes over the body of the clitoris, serving to depress the organ, and to compress the dorsal vein; *d*, posterior tendinous division of the same muscle; *e*, pars intermedia; *f*, glans clitoridis; *g*, veins proceeding from the nymphæ; *h*, dorsal vein of the clitoris; *i*, branches communicating with the obturator veins; *k*, branches ascending to the epigastric veins; *l*, obturator veins; *m*, corpus clitoridis; *n*, crus clitoridis of the left side.

Blood-vessels of the external organs. — The *arteries* are supplied by the terminal branches of the internal pudics and from branches of the femoral.

The pudic sends off two branches: the first, or lower (*superficial perineal branch*), terminates in the labium after supplying the sphincter vaginæ and some of the perineal muscles. The second, or superior, mounting along the ischio-pubic rami to the division of the crura clitoridis, sends off a branch (*artery of the bulb*) to the bulbus vestibuli, and then separates into two terminal twigs, the one (*profunda branch*) entering the cavernous substance of the clitoris, while the other forms the *dorsal artery* of that body (*fig.* 481. *h*).

The femoral supplies the *external pudics*, two in number on each side, which arise by a common trunk or singly from the inner side of that vessel. The superior of these branches (*superior pudenda externa*) arises near the crural arch and, passing inwards, sends off two branches, one to the mons veneris and lower part of the abdominal integuments, the other, terminating in the labium, sends also twigs to the nympha and preputium clitoridis. The inferior branch (*inferior pudenda externa*), arising a little below the former, or from the profunda, passes obliquely towards the labium in which it terminates, anastomosing also with the superficial perineal branch of the pudic.

Veins.—The veins of the clitoris and the

venous plexuses surrounding the vaginal orifice, together with their communicating branches, have been already described. The *external pudic veins*, collecting the blood from the mons veneris and the interior of the labia, take a course similar to that of the corresponding arteries, and empty themselves into the saphena.

The lymphatics of the external organs terminate in the inguinal glands.

The nerves.—The external parts are abundantly supplied with nerves derived chiefly from the pudic. The pudic nerve arising from the lower part of the sacral plexus passes through the sacro-sciatic foramen and accompanying the pudic vessels divides into two branches.

The *inferior, or perineal branch*, sends twigs to the labia, nymphæ, and roots of the clitoris, and then gives off the *superficial perineal branch*, which is distributed to the constrictor muscle of the bulb of the vagina.

The *superior, or branch of the clitoris*, corresponds with the dorsal nerve of the penis. Beneath the pubic arch it passes between the roots of the clitoris and is distributed along the side of that organ in the manner already described (*fig.* 481. *ii*). Some of its ramifications are distributed upon the prepuce and in the nymphæ and upper parts of the labia.

The labium also receives nerves from the branches of the *inferior pudendal* nerve, a division of the small sciatic nerve. These communicate with the superficial perineal branches.

Abnormal Anatomy of the External Organs.

Labia.—The labia, together with the whole of the external generative organs, may be deficient, or they may retain through life an undeveloped or fœtal condition, consisting only of a very narrow fold of integument. In rarer cases, the labium of one side only has been developed. The labia may, on the other hand, present the form of a double or even a triple fold. In cases of deficiency of the lower part of the abdominal integument and anterior wall of the bladder, with separation of the pubic symphysis, the labia are imperfectly formed, and are set wider apart than usual, inclining somewhat outwards. The labial commissure is then also deficient. The posterior commissure of the labia may be much hypertrophied, projecting unusually forward, and covering more or less the entrance to the vagina. The labia are occasionally so completely coherent along the median line, that the vulvar fissure is obliterated, leaving only an aperture sufficient for the passage of urine. This condition is commonly the result of inflammation of the vulva in early infancy.

The diseases affecting the tissues of the labia may be superficially seated, or may involve more or less their entire substance. The principal superficial affections are erythematous inflammations, often accompanied by vesicular, chiefly herpetic or eczematous, and sometimes pustular eruptions ; enlargement of the follicles, increased secretion, occasionally watery, and in excessive quantity, occurring in combination with a solid œdematous condition of the part (oozing tumour of the labium), excoriations, aphthous or specific (chancrous) ulcers ; and condylomata, especially of the softer and syphilitic kind. The deeper seated affections are acute, and chronic inflammation of the fibrous and cellular tissue; induration and hypertrophy, sometimes of considerable extent (*elephantiasis*); serous infiltration, associated with pregnancy, or cardiac disease; suppuration producing large collections of pus within the labium ; sloughing and gangrene. The veins of the labia frequently become varicose in multiparæ, and hæmorrhagic effusions take place into their substance. These effusions may be produced during straining efforts, or by external violence, but are especially apt to occur during labour, from pressure of the child's head upon the veins returning the blood from the venous plexuses that surround the vaginal orifice, whereby the latter become over-distended and ruptured, a considerable interstitial hæmorrhage often resulting. Cysts enclosing a glairy fluid, and adventitious growths of a more solid kind, such as are common to fibrous and cellular tissue, are not unfrequently found within the labia. Cancerous degeneration is more rare, but it may occur, either alone, or in combination with vaginal or uterine cancer. The labia may suffer laceration during labour, from forcible violation of the person, and in other ways. Fistulæ, communicating with the rectum, and permitting the passage of fœcal and gaseous fluids, occasionally form in the labia as sequelæ of suppurative processes. Lastly, these parts are occasionally the seat of hernia of the intestine, and, more rarely, of the ovary.

Clitoris.—Entire absence of the clitoris probably seldom or never occurs alone. But the clitoris and nymphæ may be deficient even when the labia are present. The clitoris is sometimes so small that its presence may escape detection. More often it is of unusual size, projecting beyond the labia. Such enlargements, though occasionally occurring without degeneration of the tissues, are more commonly the result of inflammatory hypertrophy, or are occasioned by profuse condylomatous (syphilitic) growths, in which the prepuce also may be included. The clitoris is also subject to cancerous degeneration, sometimes attaining an enormous size.

Nymphæ and vestibule.—The protrusion of the nymphæ between the labia, which occurs as a normal condition in infants, is not unfrequently observed in adults, when these parts, exceeding their ordinary dimensions, hang down below the posterior commissure: their lower extremities may in rare cases be prolonged as far back as the anus. The number of the nymphæ may be increased to two (Morgagni), or even three pair (Neubauer). Excessive hypertrophy of the nymphæ is common in certain climates. It may be associated with corresponding enlargement of the

clitoris. The nymphæ are subject to the same inflammatory and specific disease as the labia, but they more commonly affect the surfaces than the substance of these parts, which, being of a denser texture than the labia, are not so easily infiltered with the venous, sanguineous, or puriform fluids, that readily collect within the latter.

The morbid conditions of the *vestibule* consist chiefly in inflammatory hypertrophy of the vestibular follicles, especially of those which immediately surround the urethral orifice and line the sides of the ostium vaginæ. They present the appearance of small red granulations. A more decided spongy vascular growth often springs from the border of the urethral orifice, where it forms either a bright red fringe, or a soft tumour, varying in size from a pea to a cherry (vascular tumour of the meatus). The vulvo-vaginal gland and its duct may be the special seat of blennorrhœa, sometimes of an infecting kind. This may be made to ooze from the orifice of the duct, by pressure behind the labium.

The most frequent varieties in the conditions of the *hymen and ostium vagina* have been already noticed.* The vaginal orifice may be nearly or completely obstructed by an adventitious membrane, or by the hymen preternaturally developed. Some of these states are congenital, but others are acquired. In either case, attention is often not called to them until after the establishment of puberty. According to their degree, they interfere with the functions of the vagina, partly or altogether preventing intromission, and rendering insemination imperfect or impossible. They impede the exit of the products of conception and the escape of the menstrual fluid. In the latter case, when menstruation is established, the fluid collects in and dilates the vagina and cervix uteri, and lastly the body of the uterus, and even the Fallopian tubes. Spontaneous rupture of the hymen, or membrane, may then occur, liberating the fluid.

PLACENTA.

The placenta is the organ provided in each pregnancy for the nutrition and respiration of the fœtus. To this it is connected on its free side by the umbilical cord, while its opposite or attached surface is united to the fundus, sides, or lower part of the body of the uterus by a layer of the decidua. A placenta exists only in the mammalia and in some of the cartilaginous fishes. It is composed of structures derived partly from the ovum and partly from the uterus. The fœtal or embryonal portion is not always furnished by the same portion of the ovum. It is sometimes constructed from the yolk sac, as in certain sharks, and the vessels which ramify in it are then the branches of the omphalo-mesenteric artery and vein. In other cases, as in the mammalia, the chorion supplies the fœtal portion, which is here rendered vascular by the umbilical vessels derived from the allantois. The maternal or uterine portion of the placenta is furnished by the decidua or lining membrane of the uterus. These two portions, viz., the fœtal and the maternal, originally distinct, and, even in their subsequent union, preserving a certain independence, become more or less closely connected together by interdigitating the one with the other. Their union may be one of mere contact, the fœtal portion forming numerous projecting vascular folds which in the form of laminæ or tufts, or single villi, are received into corresponding depressions or sulci, equally vascular, formed in the lining membrane of the uterus. Or it may consist in a more intimate conjunction of these parts, such as takes place in man, where the decidua or maternal portion forms a lamina which is spread over and united to the groups of villi that constitute the fœtal portion. In the former case at the time of parturition the two portions are separated, the fœtal processes being simply drawn out of the recesses which contained them without laceration of either of the tissues. But in the latter, the one part cannot be expelled without carrying a considerable portion of the other with it.

Form.—The mammalian placenta exhibits numerous varieties of form. In most Ruminants it is composed of numerous detached placentulæ constituting groups or bosses of vascular villi that project from the surface of the chorion, and are received into corresponding cotulæ upon the inner surface of the uterus. In the Carnivora the placenta encircles the fœtus in the form of a broad flat belt. In Pachydermata, Cetacea, and many other families, the villi are nearly evenly distributed over the whole surface of the chorion, so that the fœtus is everywhere surrounded by placenta. In some Rodentia and Quadrumana the placenta is double.

In man the placenta forms a single discoid organ, which in its natural position is slightly convex upon the outer, and concave upon the inner superficies. Its outline is generally *circular* or *oval;* it is sometimes *reniform, cordate,* or more or less *triangular.* It is rarely *bilobed* or *multilobed.*

Dimensions and weight.—The size of the placenta is exceedingly variable, bearing usually a certain proportion to the bulk of the child. A full-sized oval placenta measures 7—7½″ in its shorter, and 8—9½″ in its longer diameter, and measures 23—24″ in circumference. The thickness is generally greatest opposite to the point of entrance of the funis, where the organ measures commonly 1—1¼″, but it becomes gradually attenuated towards the margin, which is slightly rounded, measuring here only 2—4‴ in thickness. The weight of the placenta ranges from 15—30 oz. or more.

Fœtal surface.—Upon the fœtal surface of the placenta are observed portions of the amnion and chorion, together with the root of the funis and the principal branches of the umbilical arteries and vein.

Amnion.—The amnion (*fig.* 484. *am*), after furnishing the outer covering of the funis,

* See Vagina and Hymen.

passes off in all directions at the root of the cord, and spreads in a thin opaline lamina over the fœtal surface of the placenta, to which it slightly adheres. In some cases, especially when the umbilical vessels divide before entering the placenta, the amnion has no attachment at all to the latter. The amnion of the placenta does not differ in any respect from the rest of the amniotic sac, of which the placental portion constitutes about one third. Upon its fœtal surface is a single layer of flattened polygonal cells filled with delicate fat granulations.

Chorion. — The same proportion of chorion as of the amnion, namely, about one third of the entire superficies, is appropriated to the placenta. This, however, is not, like the amnion, simply an apposed membrane. It enters into the composition of the organ, and gives strength to it (*fig.* 484. *ch*). It sustains and transmits the branches of the umbilical vessels (*v f*), which adhere to, and ramify upon, its fœtal surface, between it and the amnion. This face of the chorion is united to the amnion by a thin and easily separable layer of soft pulpy tissue, constituting a portion of the *tunica media* of the ovum, while the reverse surface, which forms, as it were, the base or floor of the placenta, bears the numerous tufts or villi that make up the bulk of this organ.

Fœtal blood-vessels. — The blood-vessels of the placenta which belong to the fœtus are branches of the two umbilical arteries, and of the single umbilical vein. These, as just stated, ramify in large trunks over a considerable portion of the fœtal or under surface of the placenta, before they penetrate the chorion to gain the interior of the organ. When the fœtal vessels have been injected from the funis, their course upon this surface of the placenta is easily traced. Within the root of the cord, and at a distance of one inch from its insertion, the two umbilical arteries communicate together by a cross branch half an inch in length. Immediately on reaching the placental surface, each artery bifurcates, the branches passing off in opposite directions. A second bifurcation takes place, in the same manner, about half or three quarters of an inch from the first. And lastly, a third, at distances ranging from one to two and a half inches. Each of these dichotomous divisions is at first more or less abrupt and opposite, the vessels afterwards bending, and taking a slightly divergent or parallel course, or even somewhat approximating. After the third bifurcation, the vessels again divide and subdivide, but now at acute angles ; their extremities become lost, when they are reduced to the size of a crow quill, by dipping down suddenly, and passing through the chorion, to enter the substance of the placenta at distances varying from an inch to an inch and a half from its border. A small branch, however, in continuation, often runs on nearly to the edge. Lateral branches, of the same size as the terminal subdivisions, also leave the main vessels in all parts of their course, and dip down into the placental substance.

The branches of the veins, about sixteen in number, which return the blood from the interior of the placenta, emerge from its substance close to the points of entrance of the arteries, and take a less tortuous course than the latter. They, however, accompany these vessels, but more in the form of radiating lines, which proceed towards the root of the funis, passing under the arteries, and ultimately uniting in the single umbilical vein.

The varieties in the form of the placenta already noticed are apparently dependent upon certain modifications in the development and arrangement of these vessels, which are likewise very variable, although the same primary divisions are noticeable in all. In the *circular* placenta the root of the cord is inserted into, or near, the centre. In the *oval* form it is attached to the smaller extremity forming the *placenta en raquette*. In the *reniform* and *cordate* placenta, the insertion is likewise more or less lateral. Lastly, when the vessels of the cord divide before arriving at the surface, they form the *placenta en parasol.*

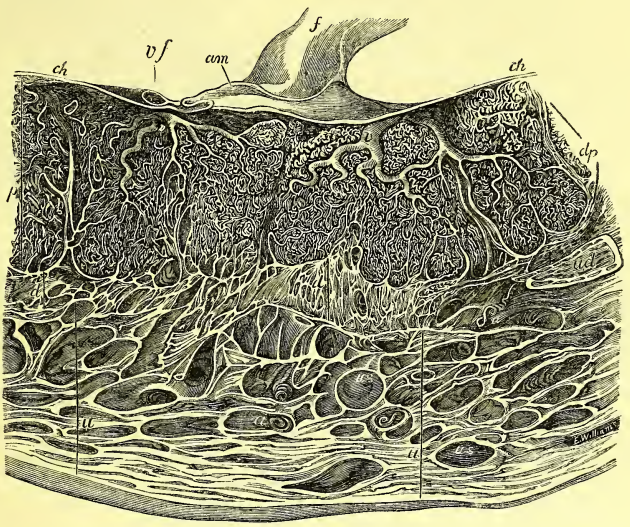
Uterine surface. — The reverse or uterine surface of a placenta which has been separated from its attachment, as in natural labour, is rough, and is divided into numerous rounded oval or angular portions, termed lobes or cotyledons. These vary from half an inch to an inch and a half in diameter. The whole of this surface consists of a thin, soft, and somewhat leathery investment of deciduous membrane, which dips down in various parts to form the sulci that separate the cotyledons from each other. This layer is a portion of the decidua which, as long as the parts are *in situ*, constitutes the boundary between the placenta and the muscular substance of the uterus, but which at the time of labour becomes split asunder, so that while a portion is carried off along with the placenta, and constitutes its external membrane, the rest remains attached to the inner surface of the uterus. This layer serves as a medium by which the uterine arteries (*fig.* 484. *a a*) and veins pass from the uterus into the placenta. Numerous valve-like apertures are observed upon all parts of the surface. They are the orifices of the veins which have been torn off from the uterus. A probe passed into any of these, after taking an oblique direction, enters at once into the placental substance. Small arteries, about half an inch in length, are also everywhere observed embedded in this layer. After making several sharp spiral turns, they likewise suddenly open into the placenta. These are the uterine vessels, which convey the maternal blood to and from the interior of the placenta.

Circumference. — The margin of the placenta is bordered all round by the united membranes which enter into its composition. Here the amnion and chorion, after lining the fœtal or concave surface, come into contact with the decidua which covers its uterine face, and the three membranes then pass off together to enclose the liquor amnii and fœtus. At this part the decidua is always most dense.

Partly within its substance is formed an incomplete sinus, the circular vein or sinus. This constitutes an interrupted channel, which more or less encircles the placenta. Several orifices are observed in its walls. Some communicate directly with the interior of the placenta, and others with the uterine sinuses.

Substance.—When a clean section has been made through the placenta (*fig.* 484.), the two surfaces already described are observed to enclose between them a soft spongy substance, which is made up principally of countless ramifications of the fœtal villi. These are attached at their base to the chorion, from

Fig. 484.



Vertical section of the walls of the uterus with the placenta attached. From a woman in the thirtieth week of gestation. (After Wagner.)

The length of the lines *u u*, serves to distinguish the uterus; *p*, the placenta, and *d d*, the decidua. To the right of the figure the decidua is separated into *ud*, uterine decidua, and *dp*, decidual prolongations which form the dissepiments dividing the placenta into lobes; *f*, funis; *am*, amnion; *ch*, chorion; *vf*, fœtal blood-vessels (divided) upon the surface of the placenta; *v v*, villi; *u s*, uterine sinuses; *a a*, curling arteries in the substance of the uterus.

which they spring, while their opposite extremities are united to the decidual layer forming the uterine boundary of the placenta. The interspaces left between the villi and their ramifications form what have been termed the cells of the placenta. They are widest between the roots of the villi, and much smaller between their extremities. In these spaces the maternal blood circulates. When injections are thrown into the placenta from the uterine arteries or veins, these spaces become filled, and the mass, when broken, exhibits a peculiar granular appearance. Dipping down among the villi, and reaching in some cases as far as the fœtal surface of the placenta, are numerous sheet-like prolongations of decidua (*fig.* 484. *d p*). These constitute the dissepiments which separate the entire mass into its several lobes or cotyledons. At the placental margin, the decidual layer generally dips under the villi, forming a return end or border, which is directed inwards, and is attached at a distance of 3—4‴ from the margin to the outer surface of the chorion. The exact relation of the decidua to the villi, in various parts of the placenta, will be better understood after a more minute description has been given of each of these structures.

The tufts and villi. — A placental tuft has been often compared to a tree. It consists of a trunk giving off numerous branches, which ultimately end in finer subdivisions or villi (*fig.* 484. *v v* and *fig.* 485. *a*). The trunks may be said to take root in the chorion, from which they spring, while the branches and finer subdivisions spread laterally and upwards, until they come into contact, at their sides, with the adjacent tufts and villi, and above with the decidua which bounds the placenta towards the uterus. Many of the villi, instead of branching like trees, proceed thread-like from the floor to the roof of the placenta, only sending off short knotty side branches. The tufts are so closely set, that their forms cannot be readily discerned until they are floated out in water. The stems are tough and fibrous, or coriaceous, while the branches and finer villi, though strong, are of a more brittle texture. When one of these is broken off, and examined by the microscope, it presents the following characteristics — the subdivisions are abrupt, contorted, and singularly

devoid of symmetry; from all parts of their surface spring numerous short pullulations, which render them knotty and uneven.

Every villus is composed of two distinct parts, viz. an outer leathery sheath, and an inner softer and vascular structure, which is contained within the former like a finger encased in a glove. The distinction between these two structures is not easily observed, except in parts where the outer sheath has been accidentally broken off, leaving the more pulpy internal substance exposed. Or in cases where the placenta has become stale by keeping for a few days, when the inner portion by shrinking has retired from the end of the villus, so that a small interspace has been here left (*fig.* 485. *b*).

When a terminal tuft so prepared is viewed by transmitted light, under slight compression, the outer case is seen to consist of a transparent non-vascular structureless membrane, embedded in the substance, or attached to the inner surface of which are numerous flattened spheroidal cells, forming generally a single layer. In the apex of a growing tuft, or forming a distinct bud projecting from its extremity, may be often observed a group of similar cells which appear to be passing off from a spot in the centre of the mass.* These cells perform important parts in the growth and offices of the villi, which will be presently noticed.

The internal portion (*fig.* 485. *b*) consists of a soft and pulpy structure which envelopes the blood-vessels of the villi. In its substance also are embedded numerous cells of a similar nature to those observed in the structureless sheath.

Termination of the fœtal vessels. — The arrangement and terminal divisions of the blood-vessels within the villi varies considerably according to the age of the placenta. The following distribution is observed from the third to the sixth month (*fig.* 485. *a*). Each villus contains one or more arteries and veins, together with numerous capillaries. The arteries pass up the centre of the stem, and divide into branches according to the number of the terminal subdivisions. Within these the branches split up into numerous capillaries, which present various forms of arrangement, in some parts resembling Malpighian bodies, and in others the arrangement of pulmonic capillaries. From these capillaries the blood is collected by veins which pass back through the tufts accompanying the corresponding arteries. All these vessels, with their subdivisions, are enveloped and supported by the pulpy granular substance that forms the interior of every villus (*fig.* 585. *b*).

Towards the end of pregnancy, the true capillaries of the villi gradually disappear, so that in a placenta at term the blood-vessels present the condition accurately described by C. H. Weber and Goodsir. A single vessel generally enters each terminal tuft, and after forming an open loop, it returns again, either dividing within the villus, or leaving it as it entered. Or a single vessel may enter, and retire from two or more villi, before it terminates in a principal vein. Many modifications occur in the forms of the loops, which may be simple, compound, wavy, or much contorted, and in parts varicose.*

Such, then, are the structures belonging to the fœtus which are brought into contact with the maternal blood in the interior of the placenta, viz. the portion of chorion that forms the floor of the placenta, and the tufts or villi which spring from its surface. The office of the former is simply mechanical in confining the maternal blood to its proper course, and preventing rupture of the organ; the latter constitutes the potential portion of the placenta.

On the other hand, the sole parts belonging to the mother, the existence of which can be anatomically demonstrated in the substance of the placenta, are formed out of the decidua.

The decidua.—A general description of this membrane, as it forms the roof of the placenta, and sends off dissepiments into its substance, has been already given. It only remains to

Fig. 485.

a, terminal villus of a fœtal tuft, from a placenta of six months. The arteries, veins, and capillaries are minutely injected. The latter, which disappear towards the end of gestation, are here very abundant. The arteries and veins occupy the centre, and the capillaries the surface, of the tuft, immediately beneath the non-vascular sheath. The nucleated non-vascular sheath is shown at *b*, separated from the internal softer structure in which the vessels ramify. (*Ad Nat.*)

* J. Goodsir. Anatomical and Pathological Observations, 1845.

* These are the only terminations of the fœtal vessels of the placenta which have been hitherto described. The true capillary system disappears towards the end of gestation, and apparently, on this account, has escaped the attention of observers, as far as I am aware, except Schrœder van der Kolk, who, in his recent work, has described and figured them in a placenta of three months. Scanzoni also (Lehrbuch der Geburtshilfe, *fig.* 99.) reproduces the figure of Meckel and Gierse, in which the capillaries have evidently been injected; but this is given as an example characteristic of a dropsical placenta, and not as representing a normal state.

explain the exact relations of this structure to the villi, within the placenta. All the extremities of the villi which are sufficiently long to reach across the placenta from the chorion to the opposite surface formed by the decidua, become firmly attached to the inner side of the latter. This attachment takes place not by any actual perforation of the decidua, but by the ends of the villi being simply inserted, in an early stage of the formation of the placenta, into little shallow pits or cup-like depressions in the decidual substance, into which they are received, and from which they may be withdrawn.* In other cases, the ends of the villi become blended with the decidua, to which they are apparently fixed, by a growth of decidual cells. These attachments are for the purpose of giving strength to the placenta, and of mechanically supporting the villi. They take place not only between the ends of the villi and the decidua forming the roof of the placenta, but also wherever decidua and villi come into contact. Hence similar attachments are also formed between the villi and the septa or dissepiments (*fig.* 484. *d p*), which divide its substance into separate lobes. Upon the floor also of the placenta all round the margin, where the decidua turns downwards and inwards to become united with the chorion, and to form the placental margin, the decidua is found for a short distance attached to the bases of the villi. And this arrangement gives to the parts an appearance as if the decidua had been here penetrated by the villi, but one which is actually occasioned by the former having, in the course of growth, become extended around the roots of the latter long after these were first formed. Occasionally also decidual cells may be found upon the surface of villi, connecting together their extremities, or forming here and there rough irregular belts upon their stems.

Termination of the maternal vessels. — No extension of the maternal blood-vessels into the substance of the placenta among or between the villi, can be demonstrated to take place. So far as anatomical evidence goes, the maternal vessels all terminate at once and abruptly upon the inner surface of the decidua. The curling arteries, after passing from the muscular coat of the uterus, obliquely for the most part, through the layer of decidua which forms the roof of the placenta, open directly into the interior of the latter; while the veins commence by equally abrupt openings which conduct through the decidual layer to the venous sinuses in the uterine walls. These venous orifices occupy three situations. The first and most numerous are scattered over the inner side of the general layer of decidua which constitutes the upper boundary of the placenta; the second form openings upon the sides of the decidual prolongations or dissepiments, which separate the lobes from each other; while the third lead directly into the interrupted channel in the margin, termed the circular sinus.

Development of the placenta. — The early steps in the formation of the placenta have been described in the account which has been already given of the development of the *decidua* during gestation (p. 653.). These first steps consist in the formation out of the decidua of a perfectly spherical chamber, in the centre of which lies the impregnated ovum.

The surface of the ovum is at this time covered everywhere by short club-like villi of equal size. The extremities of these villi are simply in contact with, but are not as yet attached to the walls of the containing chamber. Subsequently both the villi and the decidua forming the fœtal chamber undergo considerable metamorphoses. Certain portions of these become intimately united, in order to form the placenta; while other portions suffer retrogression, and take no part in its construction. The following are the principal features in these metamorphoses.

Fœtal portion. — The surface of the ovum does not long retain the peculiarity just mentioned, of being equally covered by villi. During the second month at least, if not earlier, those villi on the side furthest from the uterus cease to grow, and in consequence of the increasing expansion of the ovum become more widely scattered over this part of its surface, while those nearest to the uterus rapidly increase in size and extent, so that this portion of the ovum soon exhibits a profuse growth of villous processes, which send out their ramifications in all directions.

According to Professor Goodsir, the development and growth of the villi proceed from the groups of cells already described as occupying their bulbous extremities. These swellings on the sides and ends of the villi are their germinal spots, and are the active agents in the formation of these parts. The villus elongates by the addition of cells to its extremity, the cells passing off from the germinal spot, and the spot receding on the extremity of the villus, as the latter elongates by the additions which it receives from it.

As the villi increase in size, their strength is gradually augmented by the conversion of the membrane and cells forming their stems and larger branches into a tough white fibrous texture; while frequently, towards the end of gestation, calcification is observed to begin within the finer villi, and to proceed sometimes to so great an extent that a considerable number of them become filled up and obliterated by solid matter. While these changes are going on in the outer portion of the villi, or

* The difficulty of understanding the early steps in the construction of the placenta has arisen from the belief commonly prevalent, that the ovum on first reaching the uterus remains upon the outside of the decidua, and that the villi of the chorion penetrate its substance or enter the uterine glands in order to form the placenta. But there is no actual penetration of the decidua at any period, except that which consists in the *entire* ovum gaining a situation in the interior of this membrane shortly after its arrival in the uterus. The *tips* of the villi at a certain stage, as above described, become superficially imbedded in the walls of the fœtal chamber, which is formed of decidua; but this is not a penetration of the decidua, as commonly understood, but only a means of fixing the ovum.

that which is derived from the chorion, important modifications occur in the interior structures. Up to a certain period of gestation, the chorion and its villi contain no blood-vessels. According to the author last quoted, blood-vessels first appear in these parts when the allantois reaches and applies itself to a certain portion of the interior surface of the chorion. The umbilical vessels then communicate with the substance of the villi, and become continuous with loops in their interior. Those villi in which the blood-vessels do not undergo any further development, as the ovum increases in size, become more widely separated, and lose their importance in the œconomy. The villi, again, in which vessels form, in connection with the umbilical vessels, increase in number, and undergo certain changes in the arrangement of their constituent elements. As the blood-vessels increase in size, the cells diminish in number, but are always found surrounding the terminal loop of vessels in the situation of the germinal spot.

The injections of Schrœder van der Kolk * show a profusion of capillaries within the villi as early as the third month. And at later periods of gestation, up to the sixth month, I have succeeded without difficulty in displaying, by the aid of fine injections, such an abundant development of these vessels, as is exhibited in *fig.* 485. Before the end of gestation, however, the greater part or all of these fine capillaries have disappeared, and the vessels within the villi then show only the long tortuous varicose loops which Goodsir has so well described.

Such are the principal modifications which normally take place during the development and growth of the fœtal portion of the placenta. The changes occurring in the maternal portion, or that which is supplied by the decidua, are not less remarkable.

Maternal portion. — Four principal stages may be observed in the formation of this portion of the placenta.

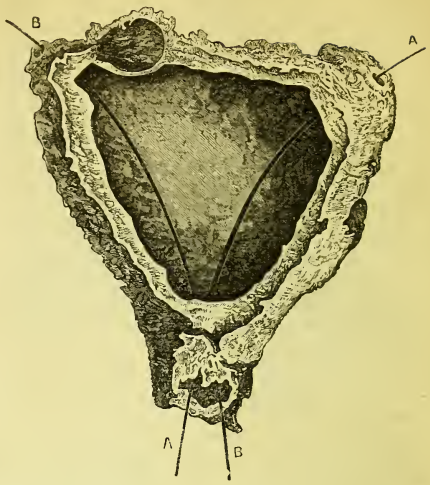
The first stage is that in which the decidua constitutes a perfectly spherical chamber † surrounding the ovum, but having as yet no structural connection with it (*fig.* 486.). This is the condition of the ovum in the early part of the first month of gestation.

The second stage is marked by the commencing attachment of the villi all round to the inner surface of the containing chamber, so that now the ovum becomes fixed, and can no longer be turned out, except by breaking off the villi, or drawing out their ends from the little pits, or anfractuosities, already described in the walls of the decidua, in which they have become embedded. At this period (latter half of the first month), the decidua forming the walls of this chamber is sufficiently firm to admit of dissection, and already there may be traced, upon its inner surface,

* Loc. cit. pl. i. *fig.* 1.

† For an account of the formation of the fœtal chamber, and of the early steps in the construction of that portion of the placenta which belongs to the decidua, see p. 653.

Fig. 486.

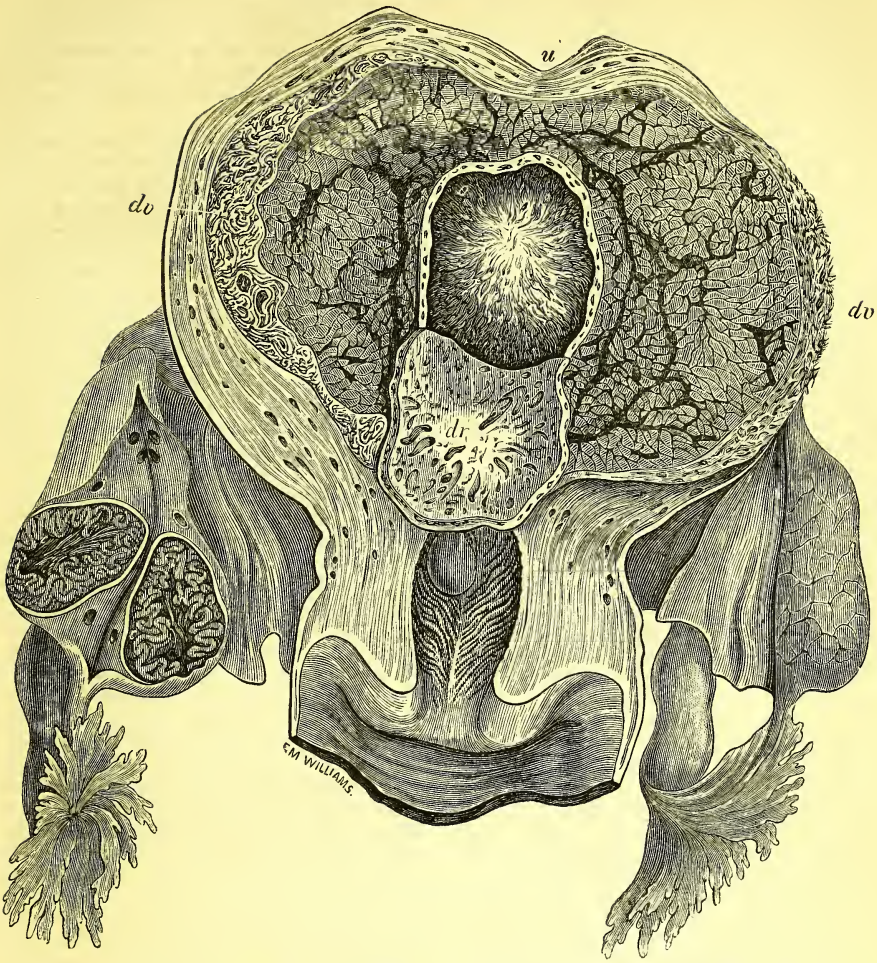


Decidua at the beginning of gestation, exhibiting the fœtal chamber in the first stage of its formation. The ovum, being at this time unattached, has dropped out of it. (*After W. Hunter.*)

orifices communicating with canals in the decidua that lead into the uterine sinuses. The maternal blood already flows freely into the fœtal chamber, and, after passing everywhere among the villi, is returned into the uterine veins. Thus a *temporary placenta* is formed, which, as in Pachydermata, Cetacea, &c., entirely surrounds the ovum (*fig.* 487.).

The third stage is the most important. It marks the transition from the temporary to the permanent form of the placenta. Coincidently with the increased development of the villi on one side of the chorion, and their corresponding arrest of growth on the opposite surface, there occurs an increase of the space between the decidua and the ovum on one side, and a corresponding decrease of it upon the opposite side. The increase is always on the side next the uterus, where the villi are most abundant, and the decrease upon the opposite surface, where they are fewest. And this change continues progressively, until, upon the bald side of the ovum, the decidua reflexa and the chorion come into so close contact that the interspace is obliterated, and the blood, which formerly flowed freely among the villi, is now no longer admitted to this part of the circumference of the ovum ; while, upon the side which is directed towards the uterus, a large space is left which now takes the form of a meniscus. In order more effectually to confine the blood within this limited space, an increased development of decidual cells now takes place, which pass off from the uterine walls, and attach themselves to the chorion all round the circumference of this space, and thus is formed the margin of the permanent placenta. During all this time, the ovum, by its growth, has been gradually raising the decidua above and around it, just as the common integument becomes raised dur-

Fig. 487.



The formation of the fœtal chamber more advanced than in fig. 486. *The ovum is still evenly covered by villi, the ends of which, about this time, begin to be attached to the walls of the chamber in which the ovum is contained.*

o, ovum; *dr*, decidua reflexa, forming the fœtal chamber; *dv*, decidua vera; *u*, uterine walls.

ing the formation of a subcutaneous abscess; while in proportion as the base of the chamber becomes extended by the gradual retiring, from the centre, of the line of reflexion of the decidua, like waves receding from a central point, so, at the same time, an increasing surface is produced by the expansion of the uterus itself; and the layer of decidua here formed, commonly termed the decidua serotina, is simply the mucous membrane reproduced to supply the place of that which had been consumed or pushed off in forming the decidua reflexa.

The fourth or final stage consists in the partitioning of the permanent placenta into smaller portions or lobes by the extension of the layer of decidua (serotina) which lies opposite to the developed villi inwards at various points towards the chorion. In this way are constructed the dissepiments already described as bounding the several lobes or cotyledons. This partitioning of the placenta commences about the fourth month.

Thus, during these several stages in the formation of the placenta, two processes may be said to be concurrently carried on which tend in opposite directions — a process of positive enlargement and growth combined with one of relative retrogression or limitation. For while the bulk of the placenta is progressively increasing up to the completion of pregnancy, the relative amount of surface of the ovum appropriated to it is, on the other hand, diminished. The entire surface of the chorion being, in the first stages of development, employed as a placenta; while in the latter half of gestation, one third of it suffices for that purpose.

Functions of the placenta. — By means of

the placenta, the blood of the mother is brought into mediate relation with that of the fœtus. Two currents, the one fœtal, and the other maternal, are continually flowing into and from this organ, yet in channels so perfectly distinct that no direct commingling of the streams can ever take place. Nevertheless, though no passage of the form-elements of the blood can occur, yet through the partition-walls which separate these two currents, all the materials necessary to the growth of the fœtus are conveyed by endosmotic processes, and all the changes necessary to the respiration of the fœtus, and to the elimination of effete materials, are effected. The mechanism by which these ends are accomplished is of two kinds. The one consisting of means for bringing the two constantly flowing streams of blood into juxtaposition, the other of instruments for carrying on the nutritive and eliminative processes which are the objects of this conjunction.

The fœtal blood conveyed by the branches of the two umbilical arteries, is distributed to the villi, whence, after being exposed, in the finer vessels and capillaries which ramify upon their inner surface, to the influence of the maternal blood, it is returned to the funis by the branches which terminate in the single vein. The propelling power by which the blood is moved resides in the heart of the fœtus, and the whole of its circulating fluid is thus carried in successive portions through the placenta.

The maternal blood, after having its impetus diminished by the spiral course which the arteries take in passing through the walls of the uterus, as well as through the decidua, is delivered at once into the placenta, where it becomes immediately separated into fine streamlets by the villi which are so closely set as to break up the interior of the organ into countless channels. After flowing everywhere among the villi, the blood escapes back into the uterine system* by the venous orifices upon the surface of the decidua, and upon the dissepiments and marginal furrows from which it is conducted, through the decidual coat, to the sinuses in the substance of the uterus, and thence is returned to the mother's body by the uterine and spermatic veins.

During the flow of these streams through the interior of the placenta, the surface of the villi is constantly bathed by the maternal blood. Nevertheless the blood of the fœtus is separated from that of the mother — first, by the walls of its own capillaries; secondly, by the gelatinous membrane in which these ramify; and thirdly, by the external non-vascular nucleated sheath derived from the chorion. With the latter alone, the maternal blood is brought into direct contact.

Each of these structures has its distinct office. The use of the external layer of cells (*fig.* 485. *b*) has been happily illustrated by Goodsir. They are to the ovum what the spongioles are to the plant: they supply it with nourishment from the soil in which it is planted. Thus their action is selective, and they transmit to the interior of the villus the materials necessary for fœtal growth. These again are taken up by the internal layer of cells (*fig.* 485. *b*), and by them brought into direct contact with the fœtal capillaries. By a similar process, the interchanges necessary to respiration are effected through the membranous surfaces which separate the maternal and fœtal blood. And these processes, respiratory and nutritive, are continued without intermission from the moment that the two separate currents are established until the final separation of the fœtus in the act of birth. Yet, throughout pregnancy, the form of the mechanism by which these changes are effected is continually altering, either in its greater or lesser parts. The greater changes have reference chiefly to mechanical, and the lesser to vital necessities. The changes in form exhibit a beautiful series of adaptations in the capacity and strength of the placenta to the increasing amount and force of the maternal current. The original plan of the placenta, that of an interspace between two spheres (a lesser one contained within a greater) filled by maternal blood, could not be long preserved with the materials out of which the temporary organ is constructed. For as the ovum grows, the decidua reflexa, which alone confines the blood

* I can arrive at no other conclusion than that the blood in the interior of the placenta, is as much external to the maternal vascular system as it is while passing through a quill inserted between the divided ends of a vein in a living animal. Although, in this belief, I find myself opposed to the views of Weber, Müller, J. Reid, Goodsir, and Schrœder van der Kolk, who, with certain differences maintain that the blood is still retained within the maternal system. The views of these and of many other physiologists, who more or less agree with them, are divisible into two classes. According to one view, the uterine vessels either form a network in the substance of the placenta (Weber), or become expanded into an enormous sac, composed of the inner coat of these vessels, which envelopes everywhere the surface of the villi (J. Reid), so that the blood after circulating within the placenta is returned to the uterus without having been extravasated. According to the other view (Goodsir and Schrœder van der Kolk), the decidua throws a close investment over every villus, and forms that outer covering of cells which I have ascribed to the chorion; so that in this view a lamina of uterine structure still separates the maternal blood from the exterior of the villi.

On this and other points relating to the minute structure and composition of the placenta, consult *Von Baer*, Untersuchungen über die Gefässverbindung zwischen Mutter und Frucht in den Saügethieren, 1828. *Ritgen*, Beiträge zur Aufhellung der Verbindung der Menschlichen Frucht mit dem Fruchthälter. 1835. *Sharpey*, in Müller's Physiology by Baly. 1837 and 1848. *Eschricht*, De organis quæ respirationi et nutritioni fœtus mammalium inserviunt. 1837. *E. H. Weber*, in Hildebrandt's Anatomie, b. iv., and in *Wagner*, Elements of Physiology. 1841. *J. Reid*, Edinb. Med. and Surg. Journ., No. 146. *J. Dalrymple*, Medico-Chirurgical Trans., vol. xxv. 1842. *Goodsir, J.* and *H.*, Anatom. and Pathol. Observs. 1845. *Schrœder van der Kolk*, Waarnemingen over het Maaksel van de Menschelijke Placenta, en over haren Bloods-omloop. 1851.

that flows around it, becomes thinner, and finally gives way by extension. But long before this stage arrives, the whole of this portion is shut out from the maternal circulation, and the subsequent metamorphoses are directed to the strengthening of the more limited space which remains. It is on this account that the strong border of decidua is formed around the margin of the now restricted area. The base of the placenta now consists of the tough and resisting chorion; while that portion alone of the decidua which is strengthened externally by the uterine walls is retained to form the opposite boundary. Ultimately, as the current of maternal blood flows with increasing force into the placenta in proportion to the growth of the latter, this becomes subdivided by the decidual septa, which apportion the entire organ into separate placentulæ, and thus the larger supplies necessary to the increasing exigencies of the fœtus are disposed of without danger of rupture to any portion of the organ.

The changes in the more minute structures which belong to the fœtus are not less interesting. The profuse development of fine capillaries within the fœtal tufts, which is so conspicuous from the third to the sixth month, is connected not only with the functions of respiration and nutrition of the fœtus, but also with the growth of the villi themselves. But when the period of viability of the fœtus has arrived, the proportionate amount of capillary vessels within the villi becomes greatly reduced, until finally only the original stems of the vessels are left. And this relative reduction of the channels through which the fœtal blood flows, becomes more marked, until, as the time of birth approaches, many of the villi become more or less obliterated, and cease to admit blood, often in consequence of that calcareous degeneration which, from the frequency of its occurrence, may be regarded rather as a normal process significant of natural decay than as an evidence of any morbid or preternatural change.

The series of metamorphoses is closed by the degeneration of the materials which bind the placenta, and consequently the fœtus, to the uterus. The layer of decidua forming the connecting medium between the uterus and the fœtal structures, in common with the rest of this membrane, suffers slow disintegration, and its component cells are converted into molecular fat. And now the strength of the adhesion being gradually diminished, it only remains for the contractile power of the uterus to be evoked in order to accomplish the separation together of the fœtus and placenta, like ripe fruit detached from the parent bough.

The illustrations of this article marked, "ad naturam," are from original drawings and preparations in the possession of the author. For the rest of the figures the authorities are given.

The usual signs are employed: for an inch ″; for a line ‴; and for the amplification ×.

The following tabulated arrangement of the principal contents will facilitate reference to the several subjects, as well as to the books quoted in the foot notes of this article.

UTERUS AND ITS APPENDAGES.

(*Arthur Farre.*)

ANALYTICAL INDEX

TO THE

SUPPLEMENTARY VOLUME.